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The Pesticide Root Zone Model (PRZM) simulates the vertical movement of pesticides in the unsaturated soil, within and below the plant root zone, and extending to the water table using generally available input data that are reasonable in spatial and temporal requirements. The model consists of hydrology and chemical transport components that simulate runoff, erosion, plant uptake, leaching, decay, foliar washoff, and volatilization (implicitly) of a pesticide. Predictions can be made for daily, monthly, or annual output. It is designed to run on a DEC PDP 1170 mini-computer using batch jobstream submission. With modifications, however, the model will operate on other computers with FORTRAN compilers. PRZM has a separate interactive processing software module (ANPRZM) to develop and update parameter files for calibration, verification, and production run analyses. The model has undergone limited performance testing in New York and Wisconsin (potatoes), Florida (citrus), and Georgia (corn). The results of these tests demonstrate that PRZM is a useful tool for evaluating groundwater threats from pesticide use. The manual provides information and detailed guidance on parameter estimation and model operation as well as an example application to assist model users.

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USERS MANUAL FOR THE PESTICIDE ROOT ZONE MODEL (PRZM)
Release 1

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FOREWORD

As environmental controls become more costly to implement and the penalties of judgement errors become more severe, environmental quality management requires more efficient management tools based on greater knowledge of the environemental phenomena to be managed. As part of this laboratory's research on the occurrence, movement, transformation, impact, and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Groundwater contamination by leaching of pesticides is a recognized environmental problem. As an aid to environmental decision-makers, the Pesticide Root Zone Model (PRZM) was developed to predict the movement of pesticides within and below the plant root zone to assess subsequent threats of contaminating groundwater.

The manual is intended to assist the model user in developing logical, well-defined, and well-documented technical evaluations that can provide:

- frequency distributions of leaching potential that may be used in risk assessment;
- guidance for monitoring compliance with conditional registrations;
- information for selecting alternative land management practices to reduce leaching such as applying pesticides in alternate years, timing of application, reducing application rates, and splitting applications; and
- leaching potential for new chemicals.

Rosemarie C. Russo, Ph.D.
Director
Environmental Research Laboratory
Athens, Georgia

ABSTRACT

The Pesticide Root Zone Model (PRZM) simulates the vertical movement of pesticides in the unsaturated soil, within and below the plant root zone, and extending to the water table using generally available input data that are reasonable in spatial and temporal requirements. The model consists of hydrology and chemical transport components that simulate runoff, erosion, plant uptake, leaching, decay, foliar washoff and volatilization (implicitly) of a pesticide. Predictions can be made for daily, monthly or annual output. It is designed to run on a DEC PDP 1170 mini-computer using batch jobstream submission. With modifications, however, the model will operate on other computers with FORTRAN compilers.

PRZM has a separate interactive processing software module (ANPRZM) to develop and update parameter files for calibration, verification, and production run analyses. The model has undergone limited performance testing in New York and Wisconsin (potatoes), Florida (citrus) and Georgia (corn) (7), (24-25). The results of these tests demonstrate that PRZM is a useful tool for evaluating groundwater threats from pesticide use.

The manual provides information and detailed guidance on parameter estimation and model operation as well as an example application to assist model users.

This report covers a period from January 1, 1982 to October 1, 1984, and work was completed as of April 1, 1984.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The Pesticide Root Zone Model (PRZM) is a dynamic, compartmental model for use in simulating chemical movement in the unsaturated soil systems within and below the plant root zone (see Figure 1). Time-varying transport, including advection, and dispersion are represented in the program. PRZM has two major components: hydrology and chemical transport. The hydrology component for calculating runoff and erosion is based on the Soil Conservation Service curve number technique and the universal soil loss equation. Evapotranspiration is estimated from pan evaporation data or by an empirical formula if input pan data are unavailable. Evapotranspiration is divided among evaporation from crop interception, evaporation from soil, and transpiration from the crop. Water movement is simulated by the use of generalized soil terms including field capacity, wilting point, and saturation. Drainage from loose, porous and tighter compact soils is simulated. To produce soil water and solid phase concentrations, the chemical transport component calculates pesticide uptake by plants, surface runoff, erosion, decay, vertical movement, foliar loss, dispersion, and retardation. A finite difference numerical solution, using a backwards difference implicit scheme, is employed.

PRZM allows the user to perform dynamic simulations of potentially toxic chemicals, particularly pesticides, that are applied to the soil or to plant foliage. Dynamic simulations allow the consideration of pulse loads, the prediction of peak events, and the estimation of time-varying mass emission or concentration profiles, thus overcoming limitations of the more commonly used steady-state models.

1.2 EXPOSURE ASSESSMENT

Evidence of potentially toxic pesticides in groundwater has led to intensive efforts toward environmental risk assessment for existing or new chemicals. The concept of risk reflects the probability of causing an effect and implies that the organism must first have been exposed to the pesticide for sufficient time and intensity to inflict damage. The use of continuous simulation models to generate time series data to derive probability statements about hydrologic events

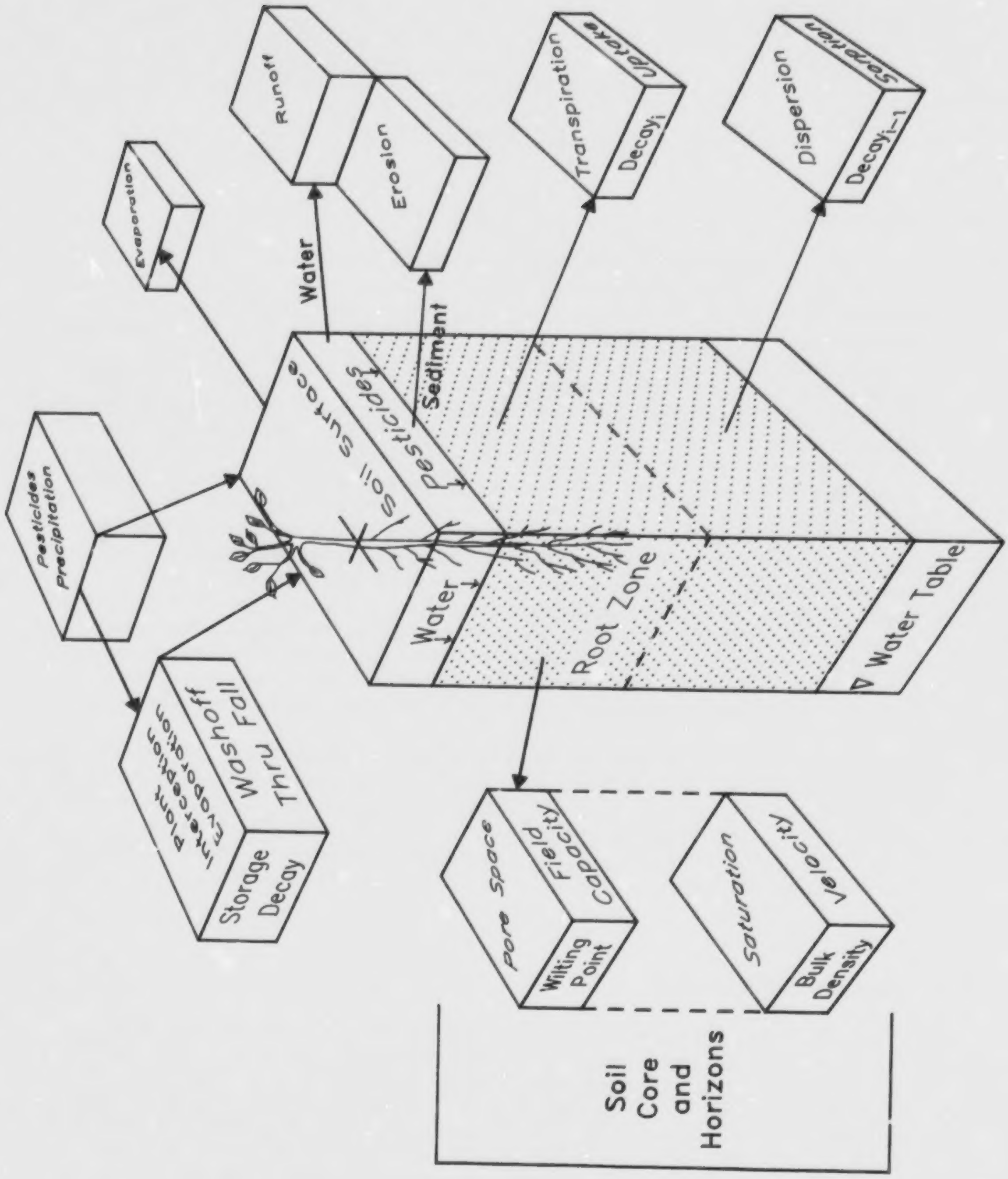
Pesticides Precipitation
Plant Interception Evaporation
Washoff Thru Fall
Storage Decay
Evaporation
Water
Runoff
Erosion
Sediment
Transpiration
Uptake
Decay$_i$
Dispersion
Sorption
Decay$_{i-1}$
Soil Surface
Pesticides
Water
Root Zone
Water Table
Pore Space
Field Capacity
Wilting Point
Saturation
Velocity
Bulk Density
Soil Core and Horizons

Figure 1. Pesticide Root Zone Model.

is an accepted technique. Simulation models have been used to estimate probabilities of environmental exposure expressed as cumulative frequency distributions in surface waters.

Frequency distributions of the mass of pesticides leaching from the plant root zone appear to be a valuable tool to assist in assigning risk to pesticide use. For example, investigations of the frequency of a specific quantity, say 10% of the amount applied, of pesticides leaching below the root zone during any one year over a 20-year period can be accomplished. A cumulative frequency distribution can be related to the expected return interval for different mass emissions. The return interval, then, can be related to risk information and a statement of risk can be determined. The study of this exposure, or exposure assessment, is defined as the evaluation of the mass (or concentration) of pesticides released into or through environmental compartments.

The source of pesticides in groundwater can arise from both nonpoint sources (agricultural use) and point sources (disposal, etc.). Nonpoint source contaminations are characterized by highly variable loadings with rainfall events dominating the timing and magnitude of the loading of pesticides leaching below the root zone. Point sources are much less varied and the loadings are thought to be steady inputs to the groundwater. Clearly, exposure assessment in the unsaturated zone must accommodate both the nonpoint and point source loading to groundwater.

Pesticide leaching from agricultural fields as nonpoint source loads can lead to groundwater contamination. The potentially widespread, areal nature of resulting contamination make remedial actions difficult because there is no single plume eminating from a "point source" (the more common groundwater problem) that can be isolated and controlled. In any case a more prudent approach to prevention or reduction of pesticide groundwater contamination must be based on understanding the relationships among chemical properties, soil system properties, and the climatic and agronomic variables that combine to induce leaching. Knowledge of these relationships can allow *a priori* investigation of conditions that lead to problems and appropriate actions can be taken to prevent widespread contamination.

Evaluation or screening process models should conform to the maximum possible extent to known theory but must be structured to enable efficient analysis of field situations with minimal requirements for specialized field data. In short, the goal is to integrate the essential chemical-specific processes for leaching with reasonable estimates of water movement through soil systems. Data input requirements are to be reasonable in spatial and temporal requirements and generally available from existing data bases.

By use of modeling techniques the user can produce a time-series of chemical mass or concentration loadings that reflect daily changes in precipitation, evapotranspiration, cropping practices, land management activities, and application timing.

1.3 OVERVIEW OF MANUAL

This manual describes a mathematical simulation model that has been developed, and partially tested, to evaluate pesticide leaching potentials under field crop conditions. Considerable emphasis has been placed on the development of a user oriented manual providing observed data or estimation techniques for each model parameter. Therefore, data are provided throughout the manual in tables, figures and appendices. In cases where the user has site-specific data, these should be used.

The user is responsible for evaluating whether the model is appropriate for the intended use, the types of data required, model parameter data and what analyses are to be accomplished with the generated time-series data.

Following the introduction is a section on modeling capability and theory. Provided is a summary of the equations solved in PRZM, where they can be found in the program, and short discussions of the transport and transformation processes included in the model.

Section 3 is an overview of the modularization of PRZM, the subroutines contained within the program, and their function within the model framework. A description of each required "card group" (a series of data records on computer file) labeled (1 - 21) is provided for preparation of data input files.

Section 4 details the estimation techniques and provides example calculations for many of PRZM's parameters. The sequence followed is in the same order as detailed in Section 3.

Section 5 discusses operational considerations of how to acquire PRZM, machine limitations, installation on a computer and a description of the pre-processing program ANPRZM.

Section 6 details an example exercise in simulation strategy for PRZM and provides a technique for groundwater threat assessment using the cumulative frequency distribution to express the probability of exposure.

The first appendix (A) is a listing of all references used in building PRZM and provides a good source of information on modeling pesticides and groundwater contamination.

The second appendix (B) is a listing of values for the hydrologic soil-cover complex of tabulated soils. These values are used in assigning curve numbers for use in the simulation. Approximately 10,000 soils are tabulated.

The third appendix (C) provides example data sets including the limited testing sets used in Long Island, New York, and Watkinsville, Georgia; sample output is provided for demonstration from the Watkinsville data set.

The fourth appendix (D) provides a julian day calendar for converting julian days (utilized by many modelers) to day/month combinations as used in PRZM.

The fifth appendix (E) provides a listing of program variables, their definition, and unit association. A supplemental programmer's guide is discussed and provides guidance on modifying PRZM's FORTRAN code.

A note on FORTRAN variables and units may be helpful. PRZM uses metric units in its calculations; the unit area simulated is one hectare.

1.4 KEY BIBLIOGRAPHY FOR USER

This manual is not intended to provide a tutorial on simulation modeling. Several sources of excellent references are provided in appendix one. The following bibliography will provde an essential background for the inexperienced user.

Burkhead, B.E., Max, R.C., Karnes, R.B., and Neid, E. Usual Planting and Harvesting Dates. USDA, Agricultural Handbook No. 283. 1972.

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SECTION 2

THEORY

2.1 INTRODUCTION

Many investigators have studied the factors contributing to pesticide leaching (4, 5, 10, 14, 37). These investigations have shown that chemical solubility in water, sorptive properties, formulation, and soil persistence determine the susceptibility of pesticides to leach through soil. Similarly, the important environmental and agronomic factors include soil properties, climatic conditions, crop type, and cropping practices. In short, the hydrologic cycle interacts with the chemical properties and characteristics to transform and transport pesticides within and out of the soil profile. Vertical movement out of and below the root zone can result in groundwater contamination and is the problem for which the model to be discussed in this manual is designed to investigate.

Modeling solute transport in porous media including soil systems is not new. Numerical models have been developed for the movement of solutes in soil columns for steady-state, transient, homogenous, and multi-layered conditions (10, 14, 17). Included in such studies have been linear and nonlinear sorption, ion exchange, and other chemical-specific reactions. These investigations have proven valuable in interpreting laboratory data, investigating basic transport processes, and identifying controlling factors in transport and transformation. As noted in a recent review of models for simulating the movement of contaminants through groundwater flow systems, however, the successful use of such models will require a great number and variety of detailed field data (2). This unfortunate conclusion arises from the scaling problems associated with laboratory experiments and the traditional solution of the appropriate partial differential equations at points or nodes in a finite-difference or finite-element grid network. Each spatial segment modeled must be properly characterized--a most expensive if not impossible, task for many modeling problems.

Such real problems in modeling pesticide leaching with existing procedures are discouraging when one considers the need to evaluate future problems arising from pesticides not yet widely distributed or used. Evaluation or screening process models should conform to the maximum possible extent to known theory but must be structured to enable efficient analysis of field situations with minimal requirements for specialized field data. In short, the goal is to integrate the essential chemical-specific processes for leaching with reasonable estimates of water movement through soil systems. Data input requirements must be reasonable in spatial and temporal requirements and generally available from existing data bases.

2.2 DESCRIPTION OF BASIC TRANSPORT EQUATIONS

The PRZM model is derived from the conceptual, compartmentalized representation of the soil profile as shown in Figure 2. From consideration of Figure 2 it is possible to write mass balance equations for both the surface zone and the subsurface zones. For the surface zone we can write

$$\frac{A\Delta X\ \partial(C_w\theta)}{\partial t} = -J_D-J_v-J_{DW}-J_u-J_{QR}-J_{ADS}+J_{DES}+J_{APP}+J_{FOF} \tag{1}$$

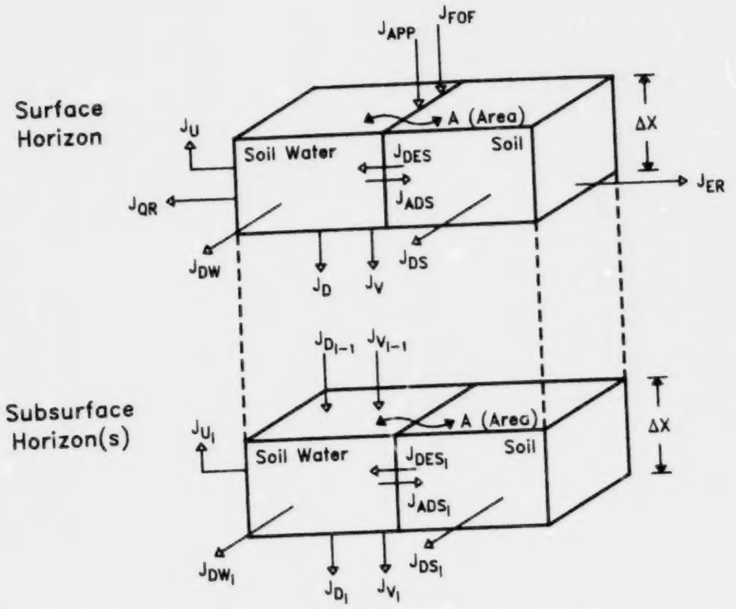
$$\frac{A\Delta X\ \partial(C_s\rho_s)}{\partial t} = -J_{DS} - J_{ER} - J_{DES} + J_{ADS} \tag{2}$$

where A = cross-sectional area of soil column, L^2
ΔX = depth dimension of compartment, L
C_w = dissolved concentration of pesticide, ML^{-3}
C_s = sorbed concentration of pesticide, MM^{-1}
θ = volumetric water content of soil, L^3L^{-3}
ρ_s = soil bulk density, ML^{-3}
t = time, T
J_D = mass rate of change by dispersion, MT^{-1}
J_v = mass rate of change by advection, MT^{-1}
J_{DW} = mass rate of change by transformation of dissolved phase, MT^{-1}
J_u = mass rate of change by plant uptake of dissolved phase, MT^{-1}
J_{QR} = mass rate of change by removal in runoff, MT^{-1}
J_{APP} = mass rate of change by pesticide application, MT^{-1}
J_{FOF} = mass rate of change by washoff from plants to soil, MT^{-1}
J_{DS} = mass rate of change by transformation of sorbed phase, MT^{-1}
J_{ER} = mass rate of change by removal on eroded recliments, MT^{-1}
J_{ADS} = mass rate of change by adsorption, MT^{-1}
J_{DES} = mass rate of change by desorption, MT^{-1}

Note that, if the kinetic representation of sorption and desorption are equated, we can also write

$$J_{DES} = J_{ADS} \tag{3}$$

and the instantaneous equilibrium assumption results.


J_{APP}
J_{FOF}
Surface Horizon
J_U
Soil Water
J_{DES}
Soil
A (Area)
ΔX
J_{QR}
J_{ADS}
J_{ER}
J_{DW}
J_D
J_V
J_{DS}
$J_{D_{l-1}}$
$J_{V_{l-1}}$
Subsurface Horizon(s)
J_{U_l}
Soil Water
J_{DES_l}
Soil
A (Area)
ΔX
J_{ADS_l}
J_{DW_l}
J_{D_l}
J_{V_l}
J_{DS_l}

ΔX = Compartment Size
J_{ADS} = Adsorption
J_{APP} = Application
J_D = Dispersion
J_{DES} = Desoprtion
J_{DS} = Decay–Soil

J_{DW} = Decay–Water
J_{ER} = Erosion
J_{FOF} = Foliar Flux
J_{QR} = Runoff
J_U = Uptake
J_V = Advection

1. Mass flow due to advection and dispersion–diffusion, $J_{D,V}$ and J_{D_l,V_l}

   $J_{D,V}$ = Flow across upper boundary of compartment

   J_{D_l}, J_{V_l} = Flux across lower boundary of compartment

   Assume: Dispersive–diffusive term is constant

2. Uptake of chemical by plant, J_U and J_{U_l}

   Assume: All of the chemical dissolved in the transpired water is taken in by the plant

3. Chemical Decomposition, J_{DW}, J_{DS} and J_{DW_l}, J_{DS_l}

   J_{DW} = Decay in the soil water phase

   J_{DS} = Decay in the soil phase

   Assume: One first order decomposition rate represents the sum of all processes in both soil water and soil phases

4. Reversible Sorption, J_{ADS}, J_{DES} and J_{ADS_l}, J_{DES_l}

   J_{ADS} = Adsorption of chemical to soil

   J_{DES} = Desorption of chemical from soil

   Assume: Equilibrium between phases is reached instantaneously

Figure 2. Compartmental model for pesticide transport in soil.

Equations for the subsurface zones are identical to equations 1 and 2 except that J_{QR}, J_{FOF}, and J_{ER} are dropped. J_{APP} applies to subsurface zones only when pesticides are incorporated into the soil.

Each term in equations 1 and 2 must now be further defined. Dispersion and diffusion are combined and are described using Fick's law as

$$J_D = - \frac{A \Delta X \ D \ \partial^2 C_w \theta}{\partial x^2} \qquad (4)$$

where D = diffusion-dispersion coefficient, assumed constant, $cm^2 \ day^{-1}$
C_w = dissolved concentration of pesticide, $g \ cm^{-3}$
θ = volumetric soil water content, $cm^3 \ cm^{-3}$
x = soil depth dimension, cm
ΔX = depth of soil, cm
A = cross-sectional area of soil column, cm^2

The advective term, J_V, describes the movement of pesticide in the bulk flow field and is written as

$$J_V = \frac{A \Delta X \partial (C_w \theta V)}{\partial x} \qquad (5)$$

where V = velocity of water movement, $cm \ day^{-1}$

Degradation of a pesticide in or on soil may be due to such processes as hydrolysis, photolysis and microbial decay. If these proceses follow pseudo first-order kinetics, the rate coefficients may be combined into one decay coefficient. Assuming the same rate constants for both phases, the rate of change of chemical out of the sorbed and dissolved pools due to decomposition may be written as:

$$J_{DW} = K_s C_w \theta \ A \Delta X \qquad (6)$$

$$J_{DS} = K_s C_s \rho_s \ A \Delta X \qquad (7)$$

where K_s = lumped, first order rate constant, day^{-1}
ρ_s = soil bulk density, $g \ cm^{-3}$
C_s = sorbed concentration of pesticide, $g \ gm^{-1}$

Plant uptake of pesticides is modeled by assuming that uptake of a pesticide by a plant is directly related to transpiration rate. If the chemical is passively carried by transpired water, then uptake is given by:

$$J_u = f\ C_w\ \Theta\ \varepsilon\ A\Delta X \qquad (8)$$

where J_u = uptake of pesticide (g cm^{-3} day^{-1})
f = the fraction of total water in the zone used for evapotranspiration (day^{-1})
ε = an uptake efficiency factor (dimensionless)

Erosion and runoff losses as well as inputs to the surface zone from foliar washoff are considered in the surface layer. The loss of pesticide due to runoff is

$$J_{qr} = \frac{Q}{A_w} C_w\ A \qquad (9)$$

J_{qr} = pesticide loss due to runoff (g day^{-1})

in which

Q = the daily runoff depth (cm day^{-1})

and the loss of pesticide due to erosion is

$$J_{er} = \frac{a\ X_e\ r_{om}\ K_d\ C_w\ A}{A_w} \qquad (10)$$

in which

J_{er} = the pesticide loss due to erosion (g cm^{-3} day^{-1})
X_e = the erosion sediment loss (tonnes day^{-1})
r_{om} = the enrichment ratio for organic matter (g g^{-1})
K_d = the adsorption partition coefficient (cm^3 g^{-1})
A_w = watershed area (cm^2)
a = a units conversion factor

Pesticides can be applied to either bare soil if pre-plant conditions prevail or to a full or developing crop canopy if post-plant treatments are desired. The pesticide application, J_{APP}, is a simple input rate but must be partitioned between the plant canopy and the soil surface. Two options are implemented in PRZM. The first simply partitions the application proportional to the ground surface covered by the plant canopy. The second approach defines the fraction, F, of the application intercepted by the plant as

$$F = 1 - \exp(-u\ W_o) \qquad (11)$$

where u = a filtration parameter (m^2 kg^{-1})
W_o = herbage areal density on a dry weight basis (kg m^{-2})

Pesticides applied to the plant canopy can be transported to the soil surface as a result of rainfall washoff. This term, J_{FOF}, is defined as

$$J_{FOF} = E\ P_r\ M\ A \qquad (12)$$

where E = extraction coefficient (cm^{-1})
P_r = daily rainfall depth ($cm\ day^{-1}$)
M = mass of the pesticide on the plant surface ($g\ cm^{-2}$) per cross-sectional area

The foliar pesticide mass, M, is further subject to degradation and volatilization and its rate of change is given by

$$\frac{AdM}{dt} = -K_f MA - J_{FOF} + A_F b \qquad (13)$$

where K_f = lumped first-order foliar rate constant (day^{-1})
A_F = application rate to the plant ($g\ ha^{-1}$)
b = a unit's conversion factor

Adsorption and desorption in equations 6 and 7 are treated as separate, kinetic processes. A convenient simplification is to assume each process is rapid and reduce this process to the expression

$$C_s = K_d\ C_w \qquad (14)$$

Equation 14 is tantamount to a linear, instantaneous, and reversible equilibrium condition in the soil-water matrix. Equation 14 also offers the convenient means to combine equations 1 and 2 into a single expression written in terms of the dissolved pesticide concentration as follows:

$$\frac{\partial[C_w(\theta+K_D\rho_s)]}{\partial t} = D\,\frac{\partial^2(C_w\theta)}{\partial x^2} - \frac{(C_w\theta V)}{\partial x}$$

$$-C_w\ [K_s(\theta+K_D\rho_s)+f\theta\varepsilon \quad + \frac{Q}{\Delta x} + \frac{aX_e r_{om} K_D}{A_W\ \Delta x}]$$

$$+ \frac{J_{APP}}{\Delta x}\ [\frac{(1-F)}{A} + FEP_r M] \qquad (15)$$

Equation 15 is solved in PRZM for the surface layer with $f\theta\epsilon = 0$; for subsurface layers within the root zone with $\frac{Q}{\Delta x}$, $\frac{aX_e r_{om} K_D}{A_w \Delta x}$, J_{APP} (except for the soil incorporated case), $EP_r M = 0$; and the same for subsurface layers below the root zone with the addition of $f\theta\epsilon = 0$.

Equation 15 is a variation on the advection-dispersion model most often derived as the basis for groundwater quality models. The plant uptake term, represented here as a simple linear function of plant transpiration, is not included in most representations and the runoff and erosion terms are rarely included. Equation 15 could be modified further to include the influence of a vapor phase pesticide component following the approach of Jury et al. (26). For many very soluble pesticides, however, volatilization from within the soil profile is not a major mode of loss (5).

Most solutions to Equation 15 (without runoff, erosion, and uptake included) have been numerical because the velocity, v, and soil moisture content, θ, are both functions of time, t, and distance, x. Assumptions of constant velocity and moisture content have been made by some investigators to enable development of analytical solutions. Specifically, for pesticides Enfield and Carsel (13) have obtained such a solution when v is both constant and known. For other situations, analytical solutions remain untractable and in any case v and θ must be known or modeled.

Because v and θ are not generally known and not generally measured as part of routine monitoring programs, it is necessary to develop additional equations for these variables. In the general case Darcy's law can be combined with the continuity equation to yield

$$\frac{\partial\theta}{\partial t} = \frac{\partial}{\partial x}\left[k \frac{(\partial\phi)}{\partial x}\right] \tag{16}$$

where k = hydraulic conductivity
ø = hydraulic potential

$$v = -k \frac{\partial\phi}{\partial x} \tag{17}$$

For the general case, Equations 15-17 must be solved as coupled equations. However, when the solute concentrations are quite low and do not influence flow then the solute transport and flow equations can be decoupled.

Equation 15 can be solved numerically. Gureghian et al. (17) obtained such a solution and performed sensitivity analyses that can give valuable insight into the leaching process. In their study, the movement of nitrogen in soil columns was investigated under transient, steady-state, and multi-layered soil conditions. Earlier Davidson et al. (10) developed numerical models for simultaneous water and solute movement in soil profiles. Pesticides were used as solutes in the study and different adsorption models were investigated for their utility in explaining the observed concentration profiles. More recently Enfield et al. (14) obtained steady-state solutions for Equation 15 for specified values of flow velocities and flow volumes (recharge). Lacking in all these approaches is accommodation of the infiltration processes at the soil surface, removal of soil moisture by evapotransporation, plant uptake, variable chemical application times and amounts, and mass balance accounting for runoff losses.

Inclusion of all the above processes in the simultaneous solution of Equations 15-17 is difficult for several reasons. First, the equations are written for vertical movement at a point, but field soils are quite variable and conditions at one point may not be representative of other points. This spatial variation is mathematically treated by solving the equations in two or three dimensions but the problem remains to characterize the physical system being modeled. Second, the vertical characteristics of field soils are also highly variable and inputs required for Equations 15-17 may not be within economical reach. In addition, the hydraulic conductivity and pressure head versus moisture content relationships of some soils may not be single-valued functions. Indeed, in a recent review of groundwater modeling, Anderson (2) noted that the scarcity of field data and the lack of appropriate measurement techniques remain as obstacles to routine application of models (advection-dispersion-Darcian) to solve contaminant transport problems. Thus, mathematical solution of Equations 15-17 by numerical methods does not necessarily lead to an effective tool for evaluating pesticide leaching risks to groundwater. Such solutions are valuable in developing fundamental insights into the governing processes to be sure, but the goal remains to develop an operational procedure for leaching assessment.

2.3 APPLICATION OF THEORY IN PRZM

Before proceeding in developing the solution to the basic equations in Section 2.2, it is useful to reconsider the pesticide leaching problem. Pesticide leaching from field-sized areas is the major concern. Because most pesticides are applied on, just beneath, or near the soil surface, the rainfall-infiltration-runoff process must be described. Movement within and below the root zone is influenced by soil moisture, which requires continuous soil moisture accounting in the model. Various field crops are of interest, each having different growth patterns, rooting depths, and transpiration requirements. Pesticide transformation process parameters (e.g., kinetic rate constants) may vary with soil depth as well as moisture and other variables so that dispersion and advection have important interactions with transformation processes. Superimposed on these factors is the objective to develop efficient, reasonably accurate solutions obtained from data generally available from national data bases, maps, and field handbooks.

Equation 16 can be solved numerically if for each time step the moisture content, θ, and pore velocity, v, are also known. Furthermore, if "field averaged" values for θ and v are estimated then the solution is no longer restricted to only a point value. In this manner a pseudo-three dimensional solution is obtained with spatial averages for two dimensions. The accuracy of this approach is quite sensitive to the distribution function that describes the field spatial variability. Existence of skewed, non-normal distributions will influence the expected value for leaching and must be acknowledged and accommodated where possible.

The hydrologic components of Equation 15 (θ, v, and X_e) can be decoupled, solved separately, and used to numerically integrate the equation in succeeding timesteps. This approach was adopted in the PRZM model. Three component problems must be solved: (1) water balance in the soil profile; (2) erosion from the soil surface; and (3) chemical transport in the soil. Each set of equations will now be presented as they are solved in the PRZM code.

2.4 WATER BALANCE EQUATIONS

Water balance equations are separately developed for: 1) the surface zone, 2) horizons comprising the active root zones, and 3) the remaining lower horizons within the unsaturated zone. The equations are:

Surface Zone

$$(SW)_1^{t+1} = (SW)_1^t + P + SM - I_1 - Q - E_1 \tag{18}$$

Root Zone

$$(SW)_i^{t+1} = (SW)_i^t + I_{i-1} - U_i - I_i \tag{19}$$

Below Root Zone

$$(SW)_i^{t+1} = (SW)_i^t + I_{i-1} - I_i \tag{20}$$

where $(SW)_i^t$ = soil water in layer "i" of the noted zone on day "t" (cm)
P = precipitation as rainfall minus crop interception, cm day^{-1}
SM = snowmelt cm day^{-1}
Q = runoff cm day^{-1}
E_i = evaporation, cm day^{-1}

U_i = transpiration cm day^{-1}
I_i = percolation out of zone i cm day^{-1}

Daily updating of soil moisture in the soil profile via the above equations requires the additional calculations for runoff, snowmelt, evaporation, transpiration, and percolation. Input precipitation is read in and pan evaporation and/or air temperature are inputs providing the potential energy from which evapotranspiration (ET) is estimated.

Incoming precipitation is first partitioned between snow or rain depending upon temperature. Air temperatures below 0.0°C produce snow. Precipitation first encounters plant interception and once the user-supplied storage is depleted the remaining daily volume is available for the runoff calculation.

The runoff calculation in PRZM is the key element in the water balance procedure. This calculation partitions the precipitation between surface runoff and infiltrating water available for leaching. Runoff is calculated by a modification of the USDA Soil Conservation Service curve number approach (18). This method was chosen because it is a reliable procedure used for many years; the required inputs are generally available; and it relates runoff to soil type, land use, and management practices.

One modification required for PRZM was the inclusion of snowmelt. First, snowmelt is estimated on days in which a snow pack exists and above freezing temperatures occur as

$$SM = C_M T \tag{21}$$

where C_M = degree day snowmelt factor (cm $°C^{-1}$ day^{-1})
T = average daily temperature (°C)

Precipitation accumulates in the snowpack when the daily average temperature is below freezing.

The precipitation and or snowmelt are inputs to the SCS runoff equation written as

$$Q = \frac{(P + SM - 0.2S)^2}{P + SM + 0.8S} \tag{22}$$

where S, the watershed retention parameter, is calibrated by

$$S = 1000/RCN - 10 \tag{23}$$

where RCN = curve number

The curve numbers are a function of soil type, soil drainage properties, crop type, and management practice. Typically, specific curve numbers for a given rainfall event are determined by the sum of the rainfall totals for the previous five days, known as the five-day antecedent moisture condition. In PRZM, the curve numbers are uniquely determined each day as a function of the soil water status in the upper soil layers. These algorithms were developed and reported by Haith et al. (18).

The daily evapotranspiration demand is divided among evaporation from canopy, soil evaporation, and crop transpiration. Total demand is first estimated and then extracted sequentially from crop canopy storage and from each layer until wilting point is reached in each layer or until total demand is met. Evaporation occurs down to a user specified depth. The remaining demand, crop transpiration, is met from the layers between this depth and the active rooting depth. The root zone growth function is activated at crop emergence and increases step-wise until maximum rooting depth is achieved at crop maturity.

Actual evapotranspiration demand is estimated as:

$$(ET)_i = MIN\ [(SW)_i^t - (WP)_i^t)*f_d^i,\ (ET)_p - \sum_{1}^{i-1} (ET)_i] \qquad (24)$$

where $(ET)_i$ = the actual evapotranspiration from layer 'i' (cm)
f_{di} = depth factor for layer 'i'
$(WP)_i$ = wilting point water content in layer 'i' (cm)
$(ET)_p$ = potential evapotranspiration (cm)

The depth factor, f_{di}, is internally set in the code. It linearly weights the extraction of ET from the root zone with depth in a triangular fashion. That is, a triangular root distribution is assumed from the surface zone to the maximum depth of rooting with the maximum root density assumed to be near the surface.

ET also is limited by soil moisture availability. The potential rate may not be met if sufficient soil water is not available to meet the demand. PRZM modifies the potential by the following equations

$$ET_p = ET_p \text{ if } SW \geq 0.6\ FC \qquad (25)$$

$$ET_p = SMFAC*ET_p \text{ if } WP < SW < 0.6\ FC$$

$$ET_p = 0 \text{ if } SW \leq WP$$

where FC = soil moisture content at field capacity
WP = soil moisture content at wilting point
SMFAC = soil moisture factor

The SMFAC parameter has been investigated in other similar water balance models (18, 49) and is internally set in the code to linearly reduce ET_p according to the limits imposed in Equations 24 and 25. Finally, if pan evaporation input data are available, ET_p is related to the input values as

$$ET_p = C_p * PE \qquad (26)$$

where PE = pan evaporation (cm day^{-1})
C_p = pan factor, dimensionless

The pan factor is constant for a given location and is a function of the average daily relative humidity, average daily windspeed, and location of the pan with respect to an actively transpiring crop.

In the absence of pan evaporation data, ET_p is estimated by

$$ET_p = 14000 \; L_d^2 \; (SVD) \qquad (27)$$

where L_d = possible hours of sunshine per day, in 12-hour units
SVD = saturated vapor density at the mean air temperature, (g cm^{-1})
SVD = $0.622(SVP)/(R_g * T_{abs})$
where (SVP) = saturated vapor pressure at the mean absolute air temperature, (mb)
R_g = dry-air gas constant
T_{abs} = absolute mean air temperature (°K)

The final term in the water balance equations that must be defined is the percolation value, I. The use of the SCS curve number approach for runoff precludes the direct use of a Darcian model. PRZM resorts to "drainage rules" keyed to soil moisture storages and the time available for drainage. Two options are included. Both are admittedly simplistic representations of soil moisture redistribution, but are consistent with the intent of model and its future uses.

Option 1.

The percolation, I, in this option is defined in the context of two bulk soil moisture holding characteristics commonly reported for agricultural soils: field capacity and wilting point. Field capacity is a somewhat imprecise measure of soil water holding properties and is usually reported as the moisture content that field soils attain after all excess water is drained from the system under influence of gravity. The difficulty with this concept is the fact that some soils will continue to drain for long periods of time and thus field capacity is not a constant. Given the lack of theoretical and physical rigor, the concept remains as a useful measure of soil moisture capacity and has been successfully used in a number of water balance models (18, 49). Wilting point of soils is a function of both soils and plants. It is defined as the soil moisture content below which plants are unable to extract water.

Field capacity and wilting point are used operationally to define two reference states in each soil layer for predicting percolation. If the soil water, SW, is calculated to be in excess of field capacity, then percolation is allowed to remove the excess water to a lower zone. The entire soil profile excess is assumed to drain within one day. The lower limit of soil water permitted is the wilting point. One outcome of these assumed "drainage rules" is that the soil layers below the root zone quickly reach field capacity and remain at that value. When this condition is reached, all water percolated below the root zone will displace the water within the lower soil layer simulated and so on. There is no allowance for lateral water movement. Water balance accounting in this manner should be most accurate for sandy soils and is least accurate for tight, clay soils (49). Fortunately, the greatest concern for leaching arises for sandy, loose soils.

Option 2.

The second option is provided to accommodate soils having low permeability layers that restrict the "free drainage" assumed in Option 1. In the context of the field capacity reference condition, two things may occur. First, conditions may prevail that raise the soil moisture levels above field capacity for periods of time because the water is "backed up" above a relatively impermeable layer. Second, the excess water may not drain during the one-day period assumed in Option 1. To accommodate these conditions two additional parameters are needed. Maximum soil moisture storage, θ^*, is added to represent moisture contents under saturated conditions. The drainage rate also must be modified to allow drainage to field capacity over periods in excess of one day (model one time-step). This is accomplished by adjusting the end of time step moisture content by

$$\theta_i^{t+1} = (\theta_i^{t*} - \theta_{fci}) \exp(-\alpha\Delta t) + \theta_{fci} \qquad (28)$$

where θ = soil layer water content ($cm^3\ cm^{-3}$)
θ_{fc} = water content at field capacity ($cm\ cm^{-1}$)

α = drainage rate parameter (day^{-1})

In this equation t and t+1 denote beginning and end of time-step values, respectively, and i is the soil layer index. The value t* denotes a value of time between beginning and end of time-step. The variable θ_i^{t*} here denotes current storage plus any percolation from the next layer above, before the occurrence of any drainage from the current layer. Because Equation 28 is solved independently for each layer in the profile, there is a possibility of exceeding the storage capability (saturation water content, θs) of a low permeability layer in the profile if a more permeable layer overlies it. At each timestep, once redistribution is complete, the model searches the profile for any $\theta i > \theta si$. If this condition is found, the model redistributes water back into overlying layers, as if the percolation of additional water beyond that necessary to saturate the low permeability layer had not occurred. This adjustment is necessary due to the nature of Equation 28 and the fact that these equations for each layer are not easily coupled. The difficulty in coupling the equations for the entire profile arises from the dicotomy that one of two factors limits percolation from a stratum in the profile; either the rate at which that stratum can transmit water, or the ability of the stratum below it to store or transmit water. This dicomtomy leads to an iterative (or at least corrective) approach to the explicit solution of a system of equations for θi, represented by Equation 28. It should be noted, however, that the value of α selected by this approach is only relevant if the permeability of the soil materials, and not sortage considerations in the profile (i.e., the presence of a water table), is the limiting factor for percolation of water.

2.5 EROSION EQUATIONS

Removal of sorbed pesticides on eroded sediments requires estimates for soil erosion. PRZM operates on a daily time-step and hence only daily storm event totals are estimated suggesting at most a total storm event resolution for the erosion calculation. The Modified Universal Soil Loss Equation (MUSLE) as developed by Williams (56) was selected. Soil loss is calculated by

$$X_e = a\,(V_r q_p)^{0.56} KLSCP \qquad (29)$$

where V_r = volume of event (daily) runoff (m^3)
q_p = peak storm runoff ($m^3 sec^{-1}$)
K = soil erodability factor
LS = length-slope factor
C = soil cover factor
P = conservation practice factor
a = units conversion factor

Most of the parameters in Equation 29 are easily determined from other calculations within PRZM (e.g., V_r) and others are familiar terms readily available from handbooks. The peak storm runoff, q_p, is not so easily characterized. In general, values for q_p vary widely and respond to precipitation and runoff dynamics. The daily total rainfall-runoff procedures adopted for PRZM do not allow individual storm event resolution of the hydrograph. Rather, a trapezoidal hydrograph is assumed with a user-specified average storm duration. From the assumed hydrograph shape and the storm duration, a peak runoff is calculated once the volume is estimated from Equation 22.

The enrichment ratio, r_{om}, is the remaining term in the overall transport equation (Equation 15) to be defined. Recall that because erosion is a selective process during runoff events, eroded sediments become "enriched" in smaller particles. The sediment transport theory available to describe this process requires substantially more hydraulic spatial and temporal resolution than used in PRZM leading us to adopt an empirical approach (33). The enrichment ratio for organic matter is calculated from

$$\ln(r_{om}) = 2 + 0.2 \ln(X_e/A_w) \qquad (30)$$

2.6 CHEMICAL TRANSPORT EQUATIONS

The second-order partial differential equation outlined in Section 2.2 must be solved with appropriate boundary conditions. A decoupled approach is taken. That is, the calculations for moisture contents, pore velocities, erosion, and runoff are decoupled from Equation 15 and solved separately. The resulting values, treated as constants for each specific time step, are then used as coefficients in a finite difference approximation of the chemical transport equation. A backwards difference, implicit scheme is used with a spatial and time step equal to those used in the water balance equations. The resulting difference equations are solved for a new dissolved pesticide concentration, C_w, at the end of the timestep.

For boundary conditions the numerical scheme uses

$$C_{w_{i-1}} \Theta_{i-1} = 0 \qquad \text{for } i = 1 \qquad (31)$$

and

$$\frac{C_{w_{i+1}} \Theta_{i+1} - C_{wi} \Theta_i}{\Delta x} = 0 \quad \text{for } i = N \qquad (31a)$$

where N = total number of compartments.

These conditions correspond to a zero concentration at the soil surface and a concentration gradient of zero at the bottom surface of the soil profile.

SECTION 3

MODEL STRUCTURE AND DATA INPUT

3.1 INTRODUCTION

A detailed flow diagram of the PRZM structure is provided in Figure 3. PRZM consists of blocks of FORTRAN statements by which computational tasks are performed. The descriptions in Figure 3 appear as comment statements (descriptive headings) to the blocks of FORTRAN statements. Should the user choose to edit the code, the anticipated change can be easily located within the program by the comment statements. This section provides an overview of the PRZM structure and parameter file.

3.2 PRZM STRUCTURE

A listing of program variables, units, and definitions are found in the programmer's guide (Appendix E). The dimensioning requirements, common blocks, and program structure also are described.

The major functions currently performed by PRZM are:

- data input
- calculation of soil moisture characteristics based on textural properties
- calculations of K_d based on water solubility models
- echo of inputs to output files
- determination of crop root growth
- meteorological time series data input
- crop interception of rainfall
- division of precipitation between rain and snow
- calculation of evapotranspiration
- snowmelt computation

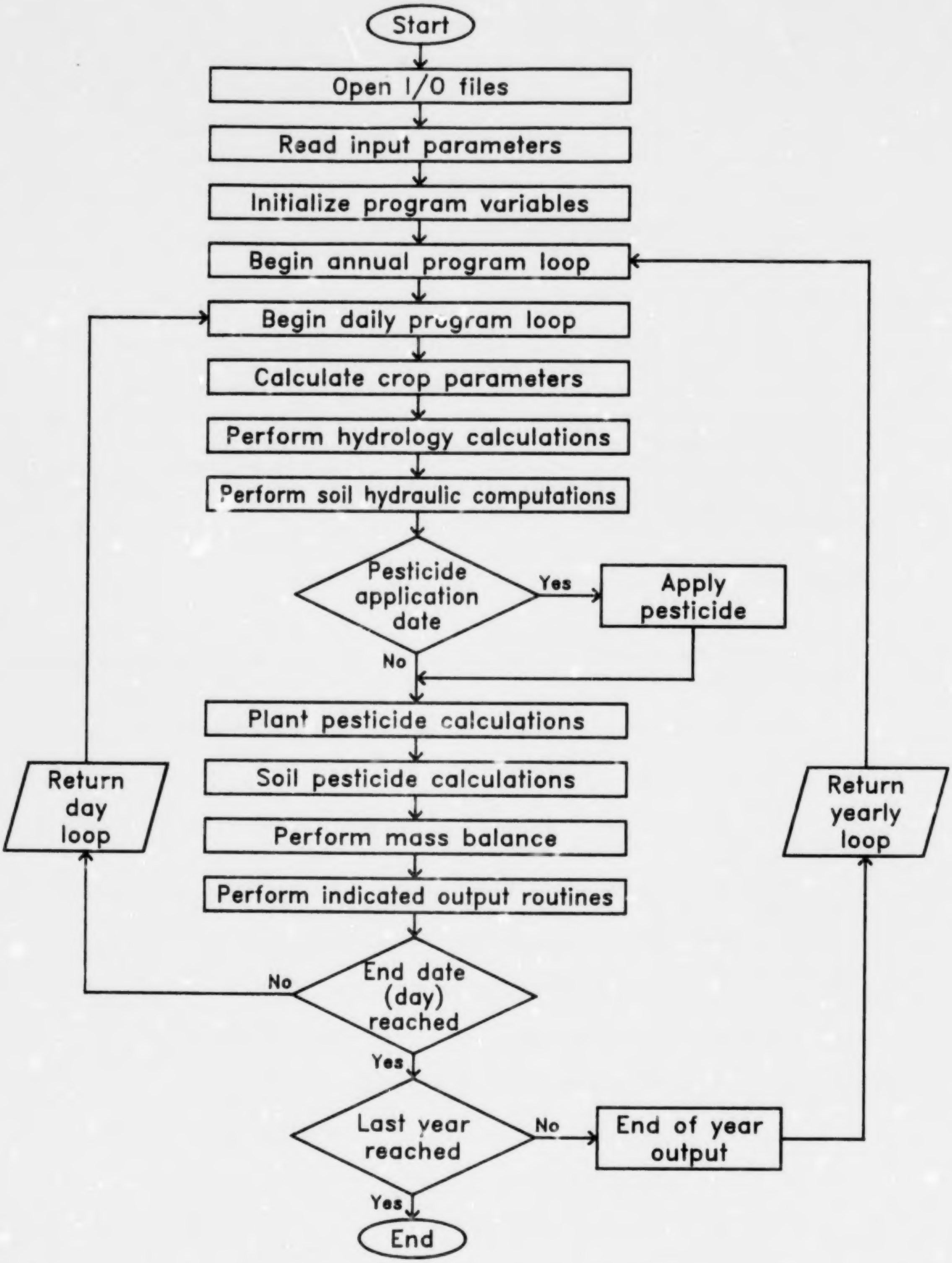

Start
Open I/O files
Read input parameters
Initialize program variables
Begin annual program loop
Begin daily program loop
Calculate crop parameters
Perform hydrology calculations
Perform soil hydraulic computations
Pesticide application date
Yes
Apply pesticide
No
Plant pesticide calculations
Soil pesticide calculations
Perform mass balance
Perform indicated output routines
Return day loop
Return yearly loop
No
End date (day) reached
Yes
Last year reached
No
End of year output
Yes
End

Figure 3. Generalized flow chart of Pesticide Root Zone Model.

- calculation of plant uptake factors
- determination of curve number from cropping period and soil moisture
- computation of runoff and infiltration
- calculation of soil hydraulics
- calculation of pesticide transport in soil
- pesticide application
- water and pesticide mass balance computation
- output of fluxes, storages, etc.
- input checking
- foliar pesticide application decay and washoff
- soil erosion and erosion pesticide loss

PRZM is a module-oriented model and contains several subroutines that calculate the functions provided in Section 3.2. A listing of subroutine names and corresponding functions are provided below.

SUBROUTINE NAMES	FUNCTIONS
ECHO	Echoes inputs from READ to an output file, checks data and prints warning messages for improper input values.
EROSN	Calculates erosion sediment loss and enrichment ratio for chemical.
EVPOTR	Computes potential evapotranspiration, soil evaporation and transpiration.
FTIME	Provides current time and date of simulation run.
HYDROL	Calculates crop interception, snow melt, runoff and surface water infiltration.
INITL	Initializes all program storages.
KDCALC	Calculates K_d by one of three models if invoked.

MAIN PROGRAM	Provides management of above subroutines, sets up program simulation loops, reads and checks time varying input data, determines types of outputs and output schedules.
MASBAL	Performs water and pesticide mass balances.
OUTCNC	Outputs pesticide concentration profiles.
OUTHYD	Accumulates fluxes and outputs summary information for water.
OUTPST	Accumulates fluxes and outputs summary information for pesticides.
OUTTSR	Outputs specific time series to plotting files.
PESTAP	Distributes pesticide appliation to either plant foliage, soil surface, or soil incorporation depths.
PLGROW	Calculates pertinent crop growth parameters.
PLPEST	Performs plant pesticide decay and washoff calculations.
READ	Reads time variant inputs and those that vary on a greater-than-daily time-step. Performs units conversions.
SLPEST	Calculation terms for pesticide decay, movement, adsorption, runoff, erosion, etc., in soil.
SOILHY	Performs soil hydraulic computations.
1)HYDR1	Well drained soils.
2)HYDR2	Poorly drained soils.
THCALC	Calculates field capacity, wilting point and saturation potentials from soil textural information if invoked.
TRDIAG	Solves for new vector of soil pesticide concentrations.

Within the main program are the open statements. These files are necessary to process (run) the job submission. There are six files in PRZM--two data input files and four result output files.

OPEN UNIT = 2 or 4 is the meteorological file

OPEN UNIT = 3 or 5 is the model parameter file

OPEN UNIT = 4 or 6 is the hydrologic result file

OPEN UNIT = 7 is the chemical result file

OPEN UNIT = 8 is the pesticide concentration output file

OPEN UNIT = 9 is the time series output file

3.3 DATA INPUT

The remainder of this section will describe the development of data input files. A brief description of the parameter is followed by a more detailed discussion (Section 4) that will aid the user in assigning values to specific input parameters. Data inputs to parameter file can be easily created by using the ANPRZM pre-processing module, as described in Section 5.

3.3.1 Meteorological File (UNIT = 2 or 4)

Information for one day only is included in each line (card) of the meteorological file.

```
    READ(4,100,END=999) MM, MD, MY, PRECIP, PEVP, TEMP

100 FORMAT (1x, 3I2, 3F10.0)                   [Model Code]

(1234567890123456789012345678901234567890123456789)  [COLUMN NUMBER]

  010179      1.50      0.340      17.2                [Example Card]
```

The format identifier, 3I2, indicates that there are six spaces (columns) for designating the month (MM), day (MD), and year (MY) of the meteorological data. The example 010179 indicates month 01, day 01, and year 1979. The 3F10.0 indicates that PRECIP, PEVP, and TEMP are to be found in three separate blocks consisting of 10 columns each. PEVP and TEMP are not always required together; various combinations are possible depending on the observed data or climate (i.e. geographical areas having major snow accumulation will require temperature data).

3.3.2 Parameter File (UNIT = 3 or 5)

Each line (representing a card) in the parameter file has a specified number of parameters in it. Each line has a formatted designation and is right justified. The user should make sure that the parameters for each line (card) required for a specific run has a value specified so that the READ statement will not go to the next line searching for a parameter file value (that would initiate an error message). Each line and the input data parameters for each line are discussed below (in the order required by the model).

CARD 1. TITLE

FORMAT (20A4)

TITLE(10): A specific title is developed for the simulation and it appears in all three result files, e.g., Calibration Run Albany, Georgia. A total of 80 characters can be input to the title card.

CARD 2. ISDAY, ISMON, ISTYR, IEMON, IEDAY, IEYR

FORMAT (2X, 3I2, 10X, 2I2)

ISDAY: Starting day of simulation, e.g., 1 =February 1st.

ISMON: Number of the starting month of simulation, e.g., 2 =February.

ISTYR: Starting year of simulation, e.g., 79.

IEDAY: Ending day of simulation, e.g., 31 =December 31.

IEMON: Number of the ending month of simulation, e.g., 12 =December.

IEYR: Ending year of simulation, e.g., 80.

CARD 3. HTITLE

FORMAT (20A4)

HTITLE(10): This card provides a comment line of 80 characters for the user to input information regarding hydrology parameters.

CARD 4. PFAC, SFAC, IPEIND, ANETD, INICRP, ISCOND

FORMAT (2F8.0, I8, F8.0, 2I8)

PFAC: Pan factor, dimensionless. This factor is multiplied by daily pan evaporation to estimate daily evapotranspiration (ET). If daily air temperatures are used for ET, any dummy number can be input for PFAC (e.g., 0.75)

SFAC: Snow factor, cm snowmelt/°C above freezing. Values of snow factor are in the order of 0.45. If snowmelt is not calculated, enter 0.00 for SFAC.

IPEIND: Pan evaporation flag. If IPEIND = 0, pan evaporation data are read. If IPEIND = 1, temperature data are read and used to calculate potential ET. If IPEIND = 2, then pan evaporation, if available, is used in the meteorologic file; if not, temperature is used to compute potential ET.

ANETD: Minimum depth, cm, in which evaporation is extracted yearly (e.g., 20.0).

INICRP: User specified initial crop number if simulation date is before first crop emergence date (see card 9).

ISCOND: User specified surface condition after harvest corresponding to INICRP (either fallow cropping, or residue, corresponding to dimensionless integer of 1, 2 or 3).

CARD 4A. DT (Only if IPIEND = 1 or 2; DO NOT include this card if IPIEND = 0)

FORMAT (8F8.0)

DT(12): Average daily hours of daylight for each month. A total of 12 values (one for each month) that are input using two lines in the parameter file.

CARD 5. ERFLAG

FORMAT (I8)

ERFLAG: Erosion flag. If erosion losses are not to be calculated, ERFLAG = 0, otherwise ERFLAG = 1.

CARD 5A. USLEK, USLELS, USLEP, AFIELD, TR (Only if ERFLAG = 1; DO NOT include this card if ERFLAG = 0).

FORMAT (5F8.0)

USLEK: Universal soil loss equation (K) soil erodibility parameter (e.g., 0.15).

USLELS: Universal soil loss equation (LS) topographic factor (e.g., 0.14).

USLEP: Universal soil loss equation (P) supporting practice factor (e.g., 1.0).

AFIELD: Area of field or plot (ha).

TR: Average duration of runoff hydrograph from runoff producing storms (hrs.).

CARD 6. NDC

FORMAT (I8)

NDC: Number of different crops used in the simulation (minimum of 1).

CARD 7. ICNCN, CINTCP, AMXDR, COVMAX, ICNAH, CN, USLEC, WFMAX

FORMAT (I8, 3F8.0,I8, 3(1X, I3), 3(1X, F3.0), F8.0)

NOTE: One card each must be read in to match the total number of crops (NDC).

ICNCN: Crop number.

CINTCP: Maximum interception storage of the crop (cm).

AMXDR: Maximum active root depth of the crop (cm).

COVMAX: Maximum areal coverage of the crop at full canopy (percent).

ICNAH: Soil surface condition after crop harvest (1 = fallow, 2 = cropping, 3 = residue).

CN: Runoff curve number for the antecedent soil water condition II, for fallow, crop, and residue fractions of the growing season (e.g. 86, 78, 82).

USLEC: Universal soil loss equation cover management factor. Three values must be entered in the same order as (CN), fallow, crop, and residue. Values only are required if ERFLAG = 1. Leaving them in the input stream will have no effect if ERFLAG = 0 (e.g., 0.20)

WFMAX: Maximum dry foliage weight of the crop at full canopy kg m^{-2}. Only required if the exponential filtration model is used for pesticide application (values of WFMAX will not affect the simulation if FAM = 1 or 2, see card 13).

CARD 8. NCPDS

FORMAT (I8)

NCPDS: Number of cropping periods in the simulation (minimum of 1). If three cropping years of continuous corn are simulated, NCPDS = 3. If two winter cover crops are in the middle of the three years of corn, NCPDS = 5.

CARD 9. EMD, EMM IYREM, MAD, MAM, IYRMAT, HAD, HAM, IYRHAR, INCROP

FORMAT (2X, 3I2, 2X, 3I2, 2X, 3I2, I8)

NOTE: One card each must be read in to match the total number of cropping periods (NCPDS).

EMD: Day of month of crop emergence (e.g., 20).

EMM: Month of crop emergence (e.g., 4).

IYREM: Year of crop emergence (e.g., 82).

MAD: Day of month of crop maturation (e.g., 15).

MAM: Month of crop maturation (e.g., 10).

IYRMAT: Year of crop maturation (e.g., 82).

HAD: Day of month of crop harvest (e.g., 20).

HAM: Month of crop harvest (e.g., 10).

IYRHAR: Year of crop harvest (e.g., 82).

INCROP: Crop number of crop growing in current period (e.g., 1).

CARD 10. PTITLE

FORMAT (20A4)

PTITLE(10): This card provides a comment line of 80 characters for the user to input information regarding pesticide parameters.

CARD 11. NAPS

FORMAT (I8)

NAPS: Number of pesticide applications (minimum of 1).

CARD 12. APD, APM, IAPYR, TAPP, DEPI

FORMAT (2X, 3I2, 2F8.0)

NOTE: One card should be entered for each application up to the number of applications (NAPS).

APD: Day of the month of pesticide application (e.g., 10).

APM: Month of pesticide application (e.g., 5).

IAPYR: Year of pesticide application (e.g., 82).

TAPP: Total pesticide application (kg ha^{-1}).

DEPI: Depth of pesticide incorporation (cm).

CARD 13. FAM

FORMAT (I8)

FAM: Pesticide application model. There are three options: FAM = 1 indicates application to soil only, FAM = 2 indicates a foliar application using the linear model, and FAM = 3 indicates a foliar application using the exponential filtration model.

CARD 13A. PLDKRT, FEXTRC, FILTRA (Only if FAM = 2 or 3; DO NOT include this card if FAM = 1).

FORMAT (3F8.0)

PLDKRT: Pesticide decay rate on plant foliage (days^{-1})

FEXTRC: Foliar extraction coefficient for pesticide washoff per centimeter of precipitation (e.g., 0.10).

FILTRA: Filtration parameter for exponential model (only required if FAM = 3).

CARD 14. STITLE

FORMAT (20A4)

STITLE(10): This card provides a comment line of 80 characters for the user to input information regarding soils properties.

CARD 15. CORED, UPTKF, NCOM2, BDFLAG, THFLAG, KDFLAG, HSWZT

FORMAT (2F8.0, 5I8)

CORED: Total depth of soil core (cm).

UPTKF: Plant uptake efficiency factor; UPTKF = 0 indicates no plant uptake simulated, UPTKF = 1 indicates uptake is simulated and is equal to the crop transpiration rate, $0<UPTKF<1$ (e.g., 0.10) indicates uptake is simulated and is a fraction of the crop transpiration rate.

NCOM2: Total number of simulation compartments in the soil core.

BDFLAG: Bulk density flag; BDFLAG = 0 indicates apparent bulk density known and entered (see CARD 17), BDFLAG = 1 indicates apparent bulk density to be calculated and mineral bulk density entered (see CARD 17).

THFLAG: Calculation flag for soil field capacity and wilting point water contents; THFLAG = 0 indicates water contents known and entered (see CARD 17A), THFLAG = 1 indicates water contents are not known and will be calculated.

KDFLAG: Calculation flag for soil/pesticide sorption partition coefficients; KDFLAG = 0 indicates partition coefficients known and entered (see 17A), BDFLAG = 1 indicates partition coefficients not known and will be calculated.

HSWZT: Switch for soil hydraulics; HSWZT = 0 indicates free draining soils, HSWZT = 1 indicates restricted draining soils.

CARD 15A. PCMC, SOL (Only if KDFLAG = 1, DO NOT include if KDFLAG = 0)

FORMAT (I8, F8.0)

PCMC: Calculation flag for model to estimate pesticide soil partition coefficients. There are three options: PCMC = 1, PCMC = 2, and PCMC = 3.

SOL: Pesticide solubility. The units vary according to the model (PCMC) selected; PCMC = 1, mole fraction; PCMC = 2, mg liter^{-1}; PCMC = 3, micromoles liter^{-1}.

CARD 16. NHORIZ

FORMAT (I8)

NHORIZ: Total number of soil horizons (minimum of 1).

CARD 17. HORIZN, THKNS, BD, DISP, DKRATE, THETO, AD

FORMAT (I8, 6F8.0)

HORIZN: Soil horizon number.

THKNS: Soil horizon thickness (cm).

BD: Soil bulk density (if BDFLAG = 0) and/or mineral bulk density (if BDFLAG = 1).

DISP: Hydrodynamic dispersion (cm^2 day^{-1}).

DKRATE: Pesticide decay rate in the soil horizon (days^{-1}).

THETO: Initial soil water content in the horizon (cm^3 cm^{-3}).

AD: Soil horizon drainage parameter (1 day^{-1}), used only if HSWZT = 1, otherwise, the value is ignored.

NOTE: Cards 17A, 17B, 17C and/or 17D are read in (as a continuation of CARD 17) for each soil horizon up to number of horizons (NHORIZ) input (CARD 16).

CARD 17A. THEFC, THEWP, KD, OC (Only if THFLAG = 0 and KDFLAG = 0)

FORMAT (8X, 4F8.0)

THEFC: Field capacity soil water content of horizon (cm^3 cm^{-3}).

THEWP: Wilting point soil water content of horizon (cm^3 cm^{-3}).

KD: Sorption partition coefficient for soil horizon/pesticide combination (cm^3 g^{-1}).

OC: Organic carbon content of soil horizon (percent). This value is also required if BDFLAG = 1.

CARD 17B. THEFC, THEWP, OC (Only if THFLAG = 0 and KDFLAG = 1)

FORMAT (8X, 3F8.0)

THEFC: Field capacity soil water content of horizon (cm^3 cm^{-3}).

THEWP: Wilting point soil water content of horizon (cm^3 cm^{-3}).

OC: Organic carbon content of soil horizon (percent). This value is also required if BDFLAG = 1.

CARD 17C. SAND, CLAY, OC, KD (Only if THFLAG = 1 and KDFLAG = 0)

FORMAT (3X, 4F8.0)

SAND: Percent sand in soil horizon.

CLAY: Percent clay in soil horizon.

OC: Organic carbon content of soil horizon (percent). This value is also required if BDFLAG = 1.

KD: Sorption partition coefficient for soil horizon/pesticide combination (cm^3 g^{-1}).

CARD 17D. SAND, CLAY, OC (Only if THFLAG = 1 and KDFLAG = 1)

FORMAT (8X, 3F8.0)

SAND: Percent sand in soil horizon.

CLAY: Percent clay in soil horizon.

OC: Organic carbon content of soil horizon (percent). This value is also required if BDFLAG = 1.

CARD 18. ILP, CFLAG

FORMAT (2I8)

ILP: Initial level of pesticide indicator. Signals user to input an initial pesticide storage. ILP = 0, indicates no initial levels input; ILP = 1, indicates initial levels are being input.

CFLAG: Conversion flag for initial pesticide level input. CFLAG = 0, indicates input in mg kg^{-1}; CFLAG = 1, indicates input in kg ha^{-1}. This flag need not be assigned if ILP = 0.

CARD 18A. PESTR (Only if ILP = 1)

FORMAT (8F8.0)

PESTR: Initial pesticide level in each compartment (up to NCOM2) as entered from CARD 15. Input must be either in mg kg^{-1} or kg ha^{-1}.

CARD 19. ITEM1, STEP1, LFREQ1, ITEM2, STEP2, LFREQ2, ITEM3, STEP3, LFREQ3

FORMAT (3 (4X, A4, 4X, A4, I8)

NOTE: For hard copy output.

ITEM1: Hydrologic output summary indicator. WATR is inserted to call hydrologic summaries. A blank is left for ITEM1 if hydrologic summaries are not desired.

STEP1: Time step of output. Three options are available: DAY for daily, MNTH for monthly, or YEAR for annual output.

LFREQ1: Frequency of soil compartment reporting. Example: LFREQ1 = 1, every compartment is output; LFREQ = 5, every fifth compartment is output.

ITEM2: Pesticide output summary indicator. PEST is inserted to call pesticide summaries (of mass migration). A blank is inserted for ITEM2 if pesticide summaries are not desired.

STEP2: Same as STEP1.

LFREQ2: Same as LFREQ1.

ITEM3: Pesticide concentration profile indicator. CONC is inserted to call pesticide concentration profile summaries. A blank is inserted if concentration profiles are not desired.

STEP3: Same as STEP1.

LFREQ3: Same as LFREQ1.

CARD 20. NPLOTS

FORMAT (I8)

NOTE: Cards 20 and 21 are for internal times series output files for later use.

NPLOTS: Number of time series to be written to plotting file (maximum of 7).

CARD 21. PLNAME, MODE, IARG, CONST (Only if NPLOTS is greater than zero)

FORMAT (4X, A4, 4X, A4, I8, F8.0)

PLNAME: Identifier of time series. Possible options are listed in Table 1.

MODE: Plotting mode. Two options are available: TSER provides the time series as output, TCUM provides the cumulative time series.

IARG: Argument of variable identified in PLNAME. Example: INFL is specified which corresponds to AINF within the FORTRAN program. AINF is dimensioned from 1 to NCOM2. IARG must be specified to identify the soil compartment (1 to NCOM2) reporting for AINF (IARG is left blank for scalers).

CONST: Specifies a constant with which the user can multiply the times series for unit conversion, etc. If left blank a default of 1.0 is used.

Table 1. Variable Designations for Plotting Files

Variable Designation (PLNAME)	FORTRAN Variable	Description	Units	Arguments Required (IARG)
Water Storages				
INTS	CINT	Interception storage on canopy	cm	None
SWTR	SW	Soil water storage	cm	1-NCOM2
SNOP	SNOW	Snow pack storage	cm	None
THET	THETN	Soil water content	cm cm^{-1}	1-NCOM2
Water Fluxes				
PRCP	PRECIP	Precipitation	cm day^{-1}	None
SNOF	SNOWFL	Snowfall	cm day^{-1}	None
THRF	THRUFL	Canopy throughfall	cm day^{-1}	None
INFL	AINF	Percolation into each soil compartment	cm day^{-1}	1-NCOM2
RUNF	RUNOF	Runoff depth	cm day^{-1}	None
CEVP	CEVAP	Canopy evaporation	cm day^{-1}	None
SLET	ET	Actual evapotranspiration from each compartment	cm day^{-1}	1-NCOM2
TETD	TDET	Total daily actual evapotranspiration	cm day^{-1}	None
Sediment Flux				
ESLS	SEDL	Event soil loss	Tonnes day^{-1}	None
Pesticide Storages				
EPST	FOLPST	Foliar pesticide storage	g cm^{-2}	None
TPST	PESTR	Total soil pesticide storage in each soil compartment	g cm^{-3}	1-NCOM2

Table 1. Variable Designations for Plotting Files (Continued)

Variable Designation (PLNAME)	FORTRAN Variable	Description	Units	Arguments Required (IARG)
Pesticides Storages				
SPST	SPESTR	dissolved pesticide storage in each soil compartment	g cm^{-3}	1-NCOM2
Pesticide Fluxes				
TPAP	TAPP	Total pesticide application	g cm^{-2} day^{-1}	None
FPDL	FPDLOS	Foliar pesticide decay loss	g cm^{-2} day^{-1}	None
WFLX	WOFLUX	Foliar pesticide washoff flux	g cm^{-2} day^{-1}	None
DFLX	DFFLUX	Individual soil compartment pesticide net diffusive flux	g cm^{-2} day^{-1}	1-NCOM2
AFLX	ADFLUX	Pesticide advective flux from each soil compartment	g cm^{-2} day^{-1}	1-NCOM2
DKFX	DKFLUX	Pesticide decay flux in each soil compartment	g cm^{-2} day^{-1}	1-NCOM2
UFLX	UPFLUX	Pesticide uptake flux from each soil compartment	g cm^{-2} day^{-1}	1-NCOM2
RFLX	ROFLUX	Pesticide runoff flux	g cm^{-2} day^{-1}	None
EFLX	ERFLUX	Pesticide erosion flux	g cm^{-2} day^{-}	None
RZFX	RZFLUX	Net pesticide flux past the maximum root depth	g cm^{-2} day^{-1}	None
TUPX	SUPFLX	Total pesticide uptake flux from entire soil profile	g cm^{-2} day^{-1}	None
TDKF	SDKFLX	Total pesticide decay flux from entire profile	g cm^{-2} day^{-1}	None

Table 1A. Conversion Factors for English and Metric Units[a]

To Convert Column 1 into Column 2, Multiply by	Column 1	Column 2	To Convert Column 2 into Column 1, Multiply by
Length			
0.621	kilometer, km	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
0.394	centimeter, cm	inch, in	2.54
Area			
0.386	kilometer^2, km^2	mile^2, mi^2	2.590
247.1	kilometer^2, km^2	acre, acre	0.00405
2.471	hectare, ha	acre, acre	0.405
Volume			
0.00973	meter^3, m^3	acre-inch	102.8
3.532	hectoliter, hl	cubic foot, ft^3	0.2832
2.838	hectoliter, hl	bushel, bu	0.352
0.0284	liter	bushel, bu	35.24
1.057	liter	quart (liquid), qt	0.946
Mass			
1.102	tonne (metric)	ton (English)	0.9072
2.205	quintal, q	hundredweight, cwt (short)	0.454
2.205	kilogram, kg	pound, lb	0.454
0.035	gram, g	ounce (avdp), oz	28.35
Pressure			
14.50	bar	lb/inch^2, psi	0.06895
0.9869	bar	atmosphere,[b] atm	1.013
0.9678	kg (weight)/cm^2	atmosphere,[b] atm	1.033
14.22	kg (weight)/cm^2	lb/inch^2, psi	0.07031
14.70	atmosphere,[b] atm	lb/inch^2, psi	0.06805
Yield or Rate			
0.446	ton (metric)/hectare	ton (English)/acre	2.240
0.892	kg/ha	lb/acre	1.12
0.892	quintal/hectare	hundredweight/acre	1.12

Table 1A. Conversion Factors for English and Metric Units[a] (Continued)

To Convert Column 1 into Column 2, Multiply by	Column 1	Column 2	To Convert Column 2 into Column 1, Multiply by
Temperature			
	Celsius	Fahrenheit	$\frac{5}{9}$ (°F - 32)
$(\frac{9}{5}\ °C) + 32$	-17.8C	0F	
	0C	32F	
	20C	68F	
	100C	212F	
Water Measurement			
8.108	hectare-meters, ha-m	acre-feet	0.1233
97.29	hectare-meters, ha-m	acre-inches	0.01028
0.08108	hectare-centimeters, ha-cm	acre-feet	12.33
0.9729	hectare-centimeters, ha-cm	acre-inches	1.028
0.00973	meters^3, m^3	acre-inches	102.8
0.981	hectare-centimeters/ hour, ha-cm/hour	feet^3/sec	1.0194
440.3	hectare-centimeters/ hour, ha-cm/hour	U.S. gallons/min	0.00227
0.00981	meters^3/hour, m^3/hour	feet^3/sec	101.94
4.403	meters^3/hour, m^3/hour	U.S. gallons/min	0.227

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[a] Soil Sci. Soc. of Amer. J., Vol. 44, No. 4, 1980.

[b] The size of an "atmosphere" may be specified in either metric or English units

SECTION 4

PARAMETER ESTIMATION

4.1 INTRODUCTION

PRZM relates pesticide leaching to temporal variations of hydrology, agronomy, and pesticide chemistry. A minimum of generally accessible input is required for successful use of PRZM. The model does utilize some parameters, however, that users may find difficult to obtain or calculate. The following section describes these parameters and provides detailed procedures for estimating or obtaining the required values. The following section is structured in the same general order that the parameters appear in the parameter file. Options are available in the program to directly estimate several parameters (THEFC, THEWP, BD, and KD) when related information is supplied by the user.

4.2 HYDROLOGY

4.2.1 Snow Factor and Pan Factor--(SFAC and PFAC) Card 4

When the mean air temperature falls below 0.0 °C, any precipitation that falls is considered to be in the form of snow. When the mean air temperature is above 0.0 °C, however, the snow accumulation is decreased by a snowmelt factor, SFAC. The amount of snowmelt is calculated by the degree-day factor and was described in Section 2 (Theory).

The mean air temperature is read from the meteorological file and provides a value for (T). The snowmelt factor, SFAC, for site specific analyses can be obtained from Linsley, Kohler, and Paulhus (31). The mid-range of their values is $\underline{0.457 \text{ cm day}^{-1}\,{}^{\circ}\text{C}^{-1}}$. The calculated snow melt is used to estimate the antecedent moisture condition and subsequently the runoff caused by the snowmelt. The snow factor would be applicable only to those areas where the climatology lends to temperatures conducive to snow fall and snow melt.

The pan factor (PFAC) is a dimensionless number used to convert daily pan evaporation to daily potential ET. The pan factor generally ranges between (0.60-0.80). Figure 4 illustrates typical pan factors in specific regions of the United States.

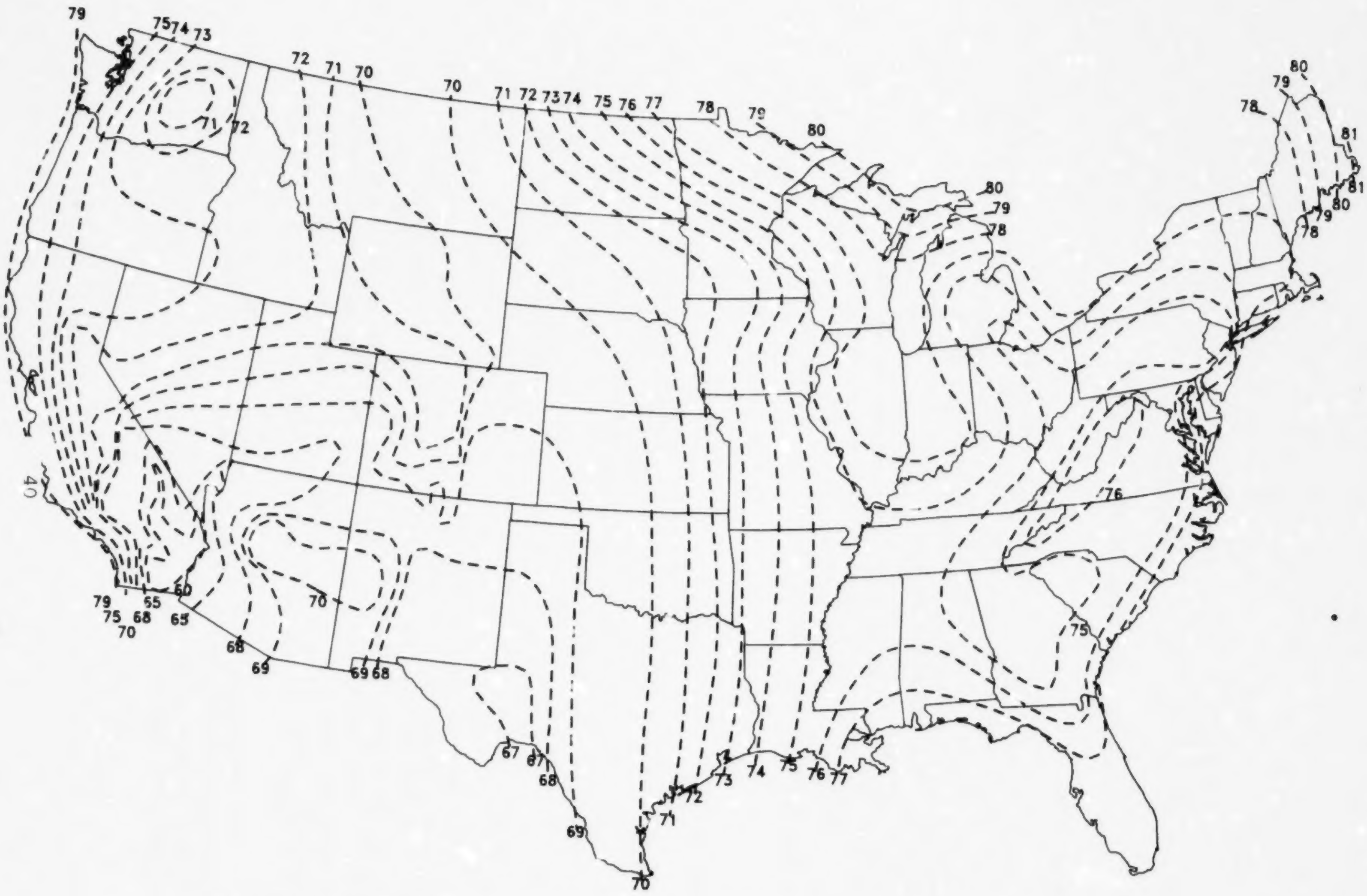
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Figure 4. Pan evaporation correction factors (from U.S. Weather Bureau).

4.2.2 Soil Evaporation Moisture Loss During Fallow, Dormant Periods--(ANETD) Card 4

The soil water balance model considers both soil evaporation and plant transpiration losses and updates the depth of root extraction. The total ET demand is subtracted sequentially in a linearly weighted manner from each layer until a minimum moisture level (wilting point) is reached within each layer. Evaporation is initially assumed to occur in the top 10 cm of the soil profile with the remaining demand, crop transpiration, occurring from compartments below the 10-cm zone and down to the maximum depth of rooting. These assumptions allow simulation of reduced levels of ET during fallow, dormant periods and increased levels during active plant growth. Values for (ANETD) used to estimate soil evaporation losses are provided in Figure 5.

The values for ANETD in Figure 5 are only applicable for hydrology option 1, the free drainage model, and would not be appropriate for use with hydrology option 2, the limited drainage model. The limited drainage model allows more available soil water and, hence, more ET extraction. If drainage option 2 is selected, it is recommended that ANETD be initially set to equal 10 cm. Further calibration may be required if results are not consistent with local water balance data.

4.2.3 Average Day Time Hours for a Day in Each Month--(DT) Card 4A

The values of DT are used to calculate total potential ET using Hamon's Formula if daily pan evaporation data do not exist. Values of DT for latitudes 24 - 50° north of the equator are provided in Table 2.

Values for DT are determined by:

Step 1. Finding the approximate degree latitude north of the equator for the agricultural use site under consideration.

Step 2. Inputting the twelve monthly numbers under the degree latitude column into the parameter file(e.g., 42° north latitude).

9.4, 10.4, 11.7, 13.1, 14.3, 14.9, 14.6, 14.0, 12.3, 10.9, 9.7, 9.0

4.2.4 Soil Erosion - Universal Soil Loss Equation--(TR, USLEK, USLELS, USLEP USLEC,) Cards 5A and 7

The role of erosion and pesticide loss on sediments decreases with decreasing chemical affinity for soil. The total mass of pesticide loss for most highly soluble pesticides will be quite small. For such situations, erosion losses can be neglible. To accommodate these conditions, the erosion flag (see Section 3) can be set equal to 0 (erosion losses not estimated). If the apparent distribution coefficient is less

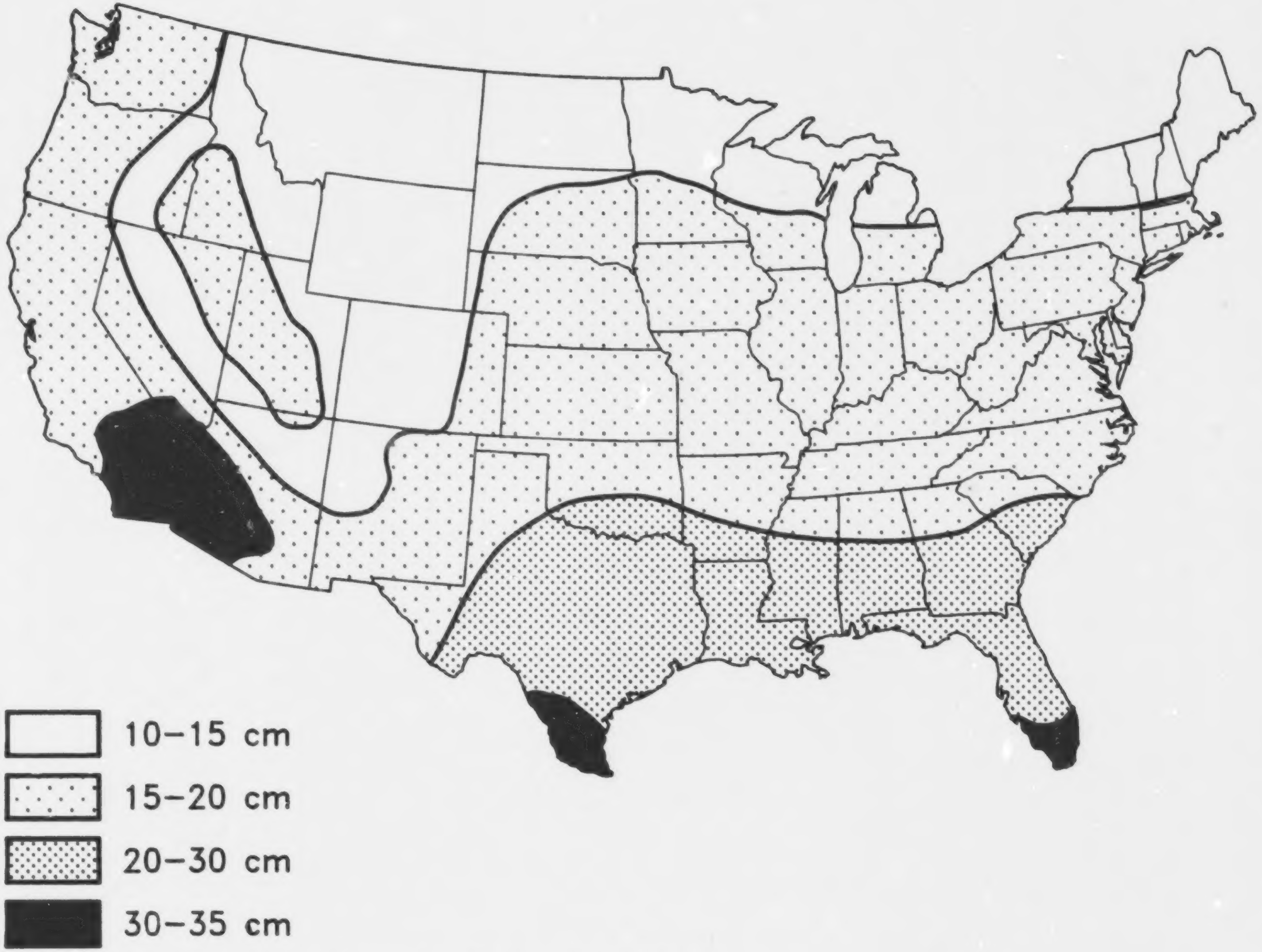
10–15 cm
15–20 cm
20–30 cm
30–35 cm

Figure 5. Diagram for estimating soil evaporation loss.

Table 2. Actual Daytime Hours for Latitudes 24° to 50° North of Equator[a]

Month	Latitudes (in degrees north of Equator)													
	24	26	28	30	32	34	36	38	40	42	44	46	48	50
Jan.	10.7	10.6	10.5	10.3	10.2	10.0	9.9	9.7	10.0	9.4	9.2	8.9	8.7	8.4
Feb.	11.2	11.1	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.0	9.9
Mar.	11.9	11.9	11.9	13.1	11.9	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.7	11.7
Apr.	12.6	12.6	12.7	12.7	12.8	12.8	12.9	13.0	13.1	13.1	12.8	13.3	13.4	13.5
May	13.1	13.7	13.4	13.5	13.7	13.7	13.9	14.1	14.2	14.3	15.0	14.7	14.9	15.1
June	13.4	13.6	13.8	13.9	14.0	14.2	14.4	14.5	14.7	14.9	15.2	15.4	15.6	15.6
July	13.3	13.4	13.5	13.7	13.9	14.0	14.1	14.3	14.4	14.6	15.0	15.0	15.3	15.5
Aug.	13.7	13.3	13.4	13.5	13.5	13.6	13.7	13.8	13.9	14.0	14.2	14.3	14.4	14.6
Sept.	12.1	12.1	12.1	12.2	12.2	12.2	12.2	12.2	12.2	12.3	12.3	12.3	12.3	12.3
Oct.	11.4	11.4	11.2	11.2	11.2	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.6	10.5
Nov.	10.8	10.7	10.6	10.5	10.4	10.5	10.1	10.0	9.8	9.7	9.5	9.3	9.6	8.9
Dec.	10.5	10.4	10.3	10.1	10.0	9.8	9.6	9.4	9.2	9.0	8.8	8.5	8.3	8.0

[a] Criddle, W. D. Methods of Computing Consumptive Use of Water., Proceedings ASCE. 84(IR 1). 1958.

than or equal to 5.0, erosion can be neglected. For a compound having a distribution coefficient greater than 5.0, erosion losses (and subsequent pesticide loss) should be estimated and the erosion flag set accordingly.

Soil characteristics, climatic conditions, agronomic practices, and topography contribute to the potential erosion rate from a field. During an erosion-producing runoff event, soil particles and aggregates are carried across the field. These aggregates consist of coarse, medium, and fine particles, with the fine particles (sediment) carried the greatest distances across the field. Sediment is the principal carrier of sorbed pesticides. The Universal Soil Loss Equation (USLE) developed by USDA is a simple method used to determine erosion losses. The USLE is most accurate for long-term average erosion losses.

The universal soil loss equation used in PRZM is the modification described by Williams, et al., Transactions ASAE, 20(6), 1977 (see Section 2 for details). The Williams modification replaces the R (rainfall erosivity) term with an energy term. The energy term enables the estimation of event totals for erosion from the field. The modified universal soil loss equation (MUSLE) requires the remaining four USLE factors with no modifications.

TR Peak runoff rate. Total runoff is easily calculated with the curve number technique, but the problem remains to estimate the peak runoff rate. Most runoff producing storms occur over a short duration. The model assumes a trapezoidal hydrograph (see Section 2) with storm duration (TR) specified as an input. Unfortunately, data to estimate TR are not often readily available.

TR is entered as an average, although in reality this parameter changes seasonally as well as with individual storm type. Because most erosion losses occur shortly after plowing or other tillage prior to crop emergence, the value of TR should be appropriate for this period. Several references (Heimstra, L. A. V. and R.C. Crease. J. Hydrol. 11, 1970.; Grace, R. A. and P. S. Eagleson. Report No. 91, Mass. Insti. Tech., 1966.; Varas, E. A. and R. K. Linsley. J. Hydrol. 34, 1977.; Eagleson, P. S. Water Res. Res. 14(5), 1978.; and Dean, J. D. MS Thesis, Univ. Ga. 1979.) give representative values of storm duration. Figure 6 provides an estimate of TR for a few locations in the United States. If more detailed information is desired, representative storm durations can be estimated from hourly rainfall records. Soil loss estimates can be adjusted by calibrating this paramter to match annual soil loss estimates. The soil loss estimates are proportional to $1/\sqrt{TR}$ (a four-fold decrease in TR will produce a two-fold increase in soil loss).

USLEK Soil erodibility factor. USLEK is a soil specific parameter. Specific values for various soils are obtainable from local Soil Conservation Service (SCS) offices. Approximate values (based on broad ranges of soil properties) can be estimated from Table 3.

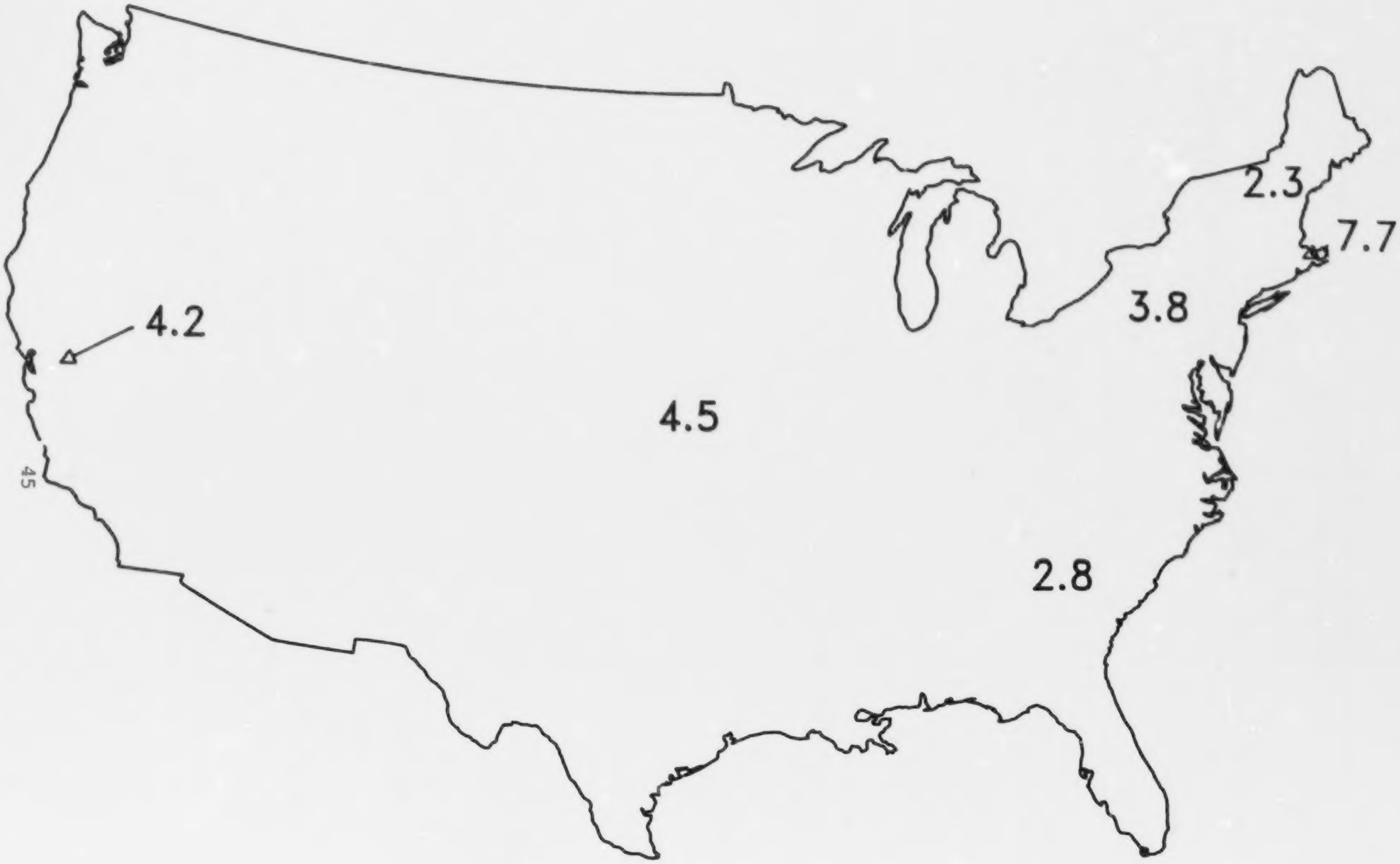
2.3
7.7
3.8
4.2
4.5
2.8

Figure 6. Diagram for estimating storm duration intervals (in hours).

Table 3. Indications of the General Magnitude of the Soil/Erodibility Factor, K[a]

Texture class	Organic Matter Content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

[a] The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values. For specific soils, Soil Conservation Service K-value tables will provide much greater accuracy. (Control of Water Pollution from Cropland, Vol. I, A Manual for Guideline Development. U.S. Environmental Protection Agency, Athens, GA. EPA-600/2-75-026a.)

USLELS	Length slope and steepness factor. USLELS is a topographic parameter and is dimensionless. Values for LS can be estimated from Table 4.
USLEP	Supporting practice factor. USLEP is a conservation supporting practice parameter and is dimensionless. Values range from 0.10 (extensive practices) to 1.0 (no supporting practice). Specific values for P can be estimated from Table 5.
USLEC	Cover and management factor. USLEC is a management parameter and is dimensionless. Values range from 0.001 (well managed) to 1.0 (fallow or tilled condition). One value for each of the three growing periods (fallow, cropping, residue) are required. Specific local values can be computed from Agricultural Handbook No. 282 (USDA) or obtained from the local SCS office. Generalized values are provided in Table 6.

4.2.5 Maximum Crop Interception--(CINTCP) Card 7

The crop interception parameter (CINTCP) estimates the amount of rainfall that is intercepted by a fully developed plant canopy and retained on the plant surface, cms. A range of 0.1 - 0.3 cm for a dense crop canopy is reported (29). Values for several major crops are provided in Table 7.

4.2.6 Active Crop Rooting Depth--(AMXDR) Card 7

PRZM requires input of the maximum active crop rooting depth (AMXDR), in centimeters, for the simulated crop (or the deepest root zone of multiple crop simulations) measured from the land surface. Generalized information for corn, soybeans, wheat, tobacco, grain sorghum, potatoes, peanuts, and cotton are provided in Table 8. If minor crops, such as mint, are simulated, or site specific information alters the generalized information, consulting with USDA Handbook No. 283 (Usual Planting and Harvesting Dates), or the Cooperative Extension Service in the specific locale is advisable.

4.2.7 Runoff and Infiltration--(CN) Card 7

The interaction of hydrologic soil group (soil) and land use and treatment (cover) is accounted for by assigning a runoff curve number (CN) for average soil moisture condition (AMC II) to important soil cover complexes for the fallow, cropping, and residue parts of a growing season[a]. The average curve numbers for each of the three soil cover complexes are estimated using Tables 8 through 12. The following steps provide a procedure for obtaining the correct curve numbers. Corn planted in straight rows will be used as an example.

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[a] Once the curve number for AMC II is located, the model calculates the curve number for AMC I and AMC III. In this way, the set of nine curve numbers required to describe each crop simulated are provided.

Table 4. Values of the Erosion Equation's Topographic Factor, LS, for Specified Combinations of Slope Length and Steepness[a]

% Slope	Slope Length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.30	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.4	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.0	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

[a] Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others. (Control of Water Pollution from Cropland, Vol. I, A Manual for Guideline Development. U.S. Environmental Protection Agency, Athens, GA. EPA-600/275-026a.)

Table 5. Values of Support-Practice Factor, P[a]

Practice	Land Slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_sc)[b]					
R-R-M-M_1	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[c]	[d]$0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[a] Control of Water Pollution From Cropland, Vol. I, A Manual for Guideline Development, U.S. Environmental Protection Agency, Athens, GA. EPA-600/2-75-026a.

[b] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[c] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[d] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Table 6. Generalized Values of the Cover and Management Factor, C, in the 37 States East of the Rocky Mountains[a,b]

Line No.	Crop, Rotation, and Management[c]	Productivity Level[d] High	Productivity Level[d] Mod.
		C value	C value
Base value:	continuous fallow, tilled up and down slope	1.00	1.00
Corn			
1	C, RdR, fall TP, conv (1)	0.54	0.62
2	C, RdR, spring TP, conv (1)	.50	.59
3	C, RdL, fall TP, conv (1)	.42	.52
4	C, RdR, wc seeding, spring TP, conv (1)	.40	.49
5	C, RdL, standing, spring TP, conv (1)	.38	.48
6	C, fall shred stalks, spring TP, conv (1)	.35	.44
7	C(silage)-W(RdL, fall TP) (2)	.31	.35
8	C, RdL, fall chisel, spring disk, 40-30% rc (1)	.24	.30
9	C(silage), W wc seeding, no-till p1 in c-k W (1)	.20	.24
10	C(RdL)-W(RdL, spring TP) (2)	.20	.28
11	C, fall shred stalks, chisel p1, 40-30% rc (1)	.19	.26
12	C-C-C-W-M, Rdl, TP for C, disk for W (5)	.17	.23
13	C, RdL, strip till row zones, 55-40% rc (1)	.16	.24
14	C-C-C-W-M-M, RdL, TP for C, disk for W (6)	.14	.20
15	C-C-W-M, RdL, TP for C, disk for W (4)	.12	.17
16	C, fall shred, no-till p1, 70-50% rc (1)	.11	.18
17	C-C-W-M-M, RdL, TP for C, disk for W (5)	.087	.14
18	C-C-C-W-M, RdL, no-till p1 2d & 3rd C (5)	.076	.13
19	C-C-W-M, RdL, no-till p1 2d C (4)	.068	.11
20	C, no-till p1 in c-k wheat, 90-70% rc (1)	.062	.14
21	C-C-C-W-M-M, no-till p1 2d & 3rd C (6)	.061	.11
22	C-W-M, RdL, TP for C, disk for W (3)	.055	.095
23	C-C-W-M-M, RdL, no-till p1 2d C (5)	.051	.094
24	C-W-M-M, RdL, TP for C, disk for W (4)	.039	.074
25	C-W-M-M-M, RdL, TP for C, disk for W (5)	.032	.061
26	C, no-till p1 in c-k sod, 95-80% rc (1)	.017	.053
Cotton[e]			
27	Cot, conv (Western Plains) (1)	0.42	0.49
28	Cot, conv (South) (1)	.34	.40
Meadow			
29	Grass & Legume mix	0.004	0.01
30	Alfalfa, lespedeza or Sericia	.020	
31	Sweet clover	.025	

Table 6. Generalized Values of the Cover and Management Factor, C, in the 37 States East of the Rocky Mountains[a,b] (Continued)

Line No.	Crop, Rotation, and Management[c]	Productivity Level[d] High	Mod.
		C value	
Base value:	continuous fallow, tilled up and down slope	1.00	1.00
Sorghum, grain (Western Plains)[e]			
32	RdL, spring TP, conv (1)	0.43	0.53
33	No-till pl in shredded 70-50% rc	.11	.18
Soybeans[e]			
34	B, RdL, spring TP, conv (1)	0.48	0.54
35	C-B, TP annually, conv (2)	.43	.51
36	B, no-till pl	.22	.28
37	C-B, no-till pl, fall shred C stalks (2)	.18	.22
Wheat			
38	W-F, fall TP after W (2)	0.38	
39	W-F, stubble mulch, 500 lbs rc (2)	.32	
40	W-F, stubble mulch, 1000 lbs rc (2)	.21	
41	Spring W, RdL, Sept TP, conv (N & S Dak) (1)	.23	
42	Winter W, RdL, Aug TP, conv (Kans) (1)	.19	
43	Spring W, stubble mulch, 750 lbs rc (1)	.15	
44	Spring W, stubble mulch, 1250 lbs rc (1)	.12	
45	Winter W, stubble mulch, 750 lbs rc (1)	.11	
46	Winter W, stubble mulch, 1250 lbs rc (1)	.10	
47	W-M, conv (2)	.054	
48	W-M-M, conv (3)	.026	
49	W-M-M-M, conv (4)	.021	

[a] This table is for illustrative purposes only and is not a complete list of cropping systems or potential practices. Values of C differ with rainfall pattern and planting dates. These generalized values show approximately the relative erosion-reducing effectiveness of various crop systems, but locationally derived C values should be used for conservation planning at the field level. Tables of local values are available from the Soil Conservation Service.

[b] Control of Water Pollution from Cropland, Vol. I, A Manual for Guideline Development. U.S. Environmental Protection AGency, Athens, GA. EPA-600/3-75-026a.

[c] Numbers in parentheses indicate number of years in the rotation cycle. No. (1) designates a continuous one-crop system.

[d] High level is exemplified by long-term yield averages greater than 75 bu. corn or 3 tons grass-and-legume hay; or cotton management that regularly provides good stands and growth.

Table 6. Generalized Values of the Cover and Management Factor, C, in the 37 States East of the Rocky Mountains[a,b] (Continued)

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[e] Grain sorghum, soybeans, or cotton may be substituted for corn in lines 12, 14, 15, 17-19, 21-25 to estimate C values for sod-based rotations.

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton

F - fallow
M - grass & legume hay
pl - plant
W - wheat
we - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding

% rc - percentage of soil surface covered by residue mulch after new crop seeding

70-50% rc - 70% cover for C values in first column; 50% for second column

RdR - residues (corn stover, straw, etc.) removed or burned

RdL - all residues left on field (on surface or incorporated)

TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

Table 7. Interception Storage for Major Crops

Crop	Density	CINTCP (cm)
Corn	Heavy	0.25 - 0.30
Soybeans	Moderate	0.20 - 0.25
Wheat	Light	0.0 - 0.15
Oats	Light	0.0 - 0.15
Barley	Light	0.0 - 0.15
Potatoes	Light	0.0 - 0.15
Peanuts	Light	0.0 - 0.15
Cotton	Moderate	0.20 - 0.25
Tobacco	Moderate	0.20 - 0.25

Table 8. Agronomic Data for Major Agricultural Crops in the United States

Crop	Representative States of Major States Production[a]	Planting Window, Month, Day (Julian Day)[b]	Crop Emergence (Days from Planting	Crop Maturity (Days from Planting)	Harvest Window, Month, Day (Julian Day)[b]	Average Yield/Acre 1977-1979[c]	Range of Active Plant Rooting Depth (cm)
Corn	IA, IL, IN, NE, OH	April 25 (115) to June 15 (166)	5-15	110-130	Sept. 25 (268) to Dec. 10 (344)	110 bu	60-120
Soybeans	IA, IL, IN, MS, OH	May 1 (121) to June 25 (176)	5-15	110-130	Sept. 15 (258) to Dec. 10 (344)	35 bu	30-60
Cotton	TX, MS, CA, AZ, AR	March 1 (60) to May 25 (145) [TX to June 20 (171)]	5-15	110-130	Sept. 1 (244) to Jan. 15 (015) [TX Aug. 1 (213) to Dec. 20 (354)]	670 lbs	30-90
Wheat	KS, OK, CA, ND, MT, WA, MN, ID	Aug. 15 (227) to Oct. 25 (298) [WA to Nov. 20 (324), CA to Feb. 15 (046)]	5-15	200-225	June 15 (166) to Sept. 20 (263)	40 bu	15-30
Potatoes	Long Island NY, ME, ID, WA, CA, OR	April 1 (091) to May 1 (121)	5-15	150-170	Sept. 1 (244) to Oct. 1 (274)	335 cwt	15-45
Peanuts	GA, TX, AL, NC, VA	April 5 (095) to June 5 (156) [TX Mar. 31 (090) to July 20 (201)]	5-15	150-175	Aug. 10 (222) to Dec. 15 (349)	2550 lbs	30-60
Tobacco	NC, SC, TN, KY, VA	April 5 (095) to June 20 (171)	Planted in Field as Seedling	120-150	July 1 (182) to Oct. 1 (274)	2000 lbs	30-60
Grain Sorghum	TX, KS, NE	TX Mar. 1 (060) to July 1 (182) KS, NE May 5 (125) to July 1 (182)	5-15	120-150	TX July 1 (182) to Nov. 20 (324) KS, NE Sept. 20 (263) to Dec. 1 (335)	62 bu	15-30

[a] Bay, D. M. and Bellinghausen, R. P. Missouri Farm Facts. Missouri Department of Agriculture. May 1979.

[b] Burkhead, B. E., Max, R. C., Karnes, R. B., and Neid, E. Usual Planting and Harvesting Dates. USDA, Agricultural Handbook No. 283. 1972.

[c] Kirkbride, J. W. (Ed.). Crop Production Annual Summary. USDA, Crop Reporting Board Publication CrPr 2-1. 1980.

Step 1. From Appendix B find the hydrologic soil group for the particular soil that is in the area under consideration[b]. There are four different soil classifications (A, B, C, D) and are in the order of decreasing percolation potential and increasing slope and runoff potential. Soil characteristics associated with each hydrologic group are as follows[c].

Group A: Deep sand, deep loess, aggregated silts, minimum infiltration of 0.76 - 1.14 (cm hr^{-1}).

Group B: Shallow loess, sandy loam, minimum infiltration 0.38 - 0.76 (cm hr^{-1}).

Group C: Clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay, minimum infiltration 0.13 - 0.38 (cm hr^{-1}).

Group D: Soils that swell significantly when wet, heavy plastic clays, and certain saline soils, minimum infiltration 0.03 - 0.13 (cm hr^{-1}).

If the soil series or soil properties are not known, the hydrologic soil group can be estimated from Figure 7.

Care must be exercised, however, in use of this figure. Considerable spatial aggregation was made in order to develop the generalized map over such a large area. Where possible development of more highly resolved data is preferable.

Step 2. From Table 9 find the land use and treatment or practice that is to be simulated (e.g., row crops, straight row).

Step 3. From Table 9 find the hydrologic condition of the soil that is to be simulated (e.g., good).

Step 4. From Table 9 find the curve number for antecedent moisture condition II for the site selected. Example: Hydrologic group = A, treatment practice is straight row, land use is row crops, hydrologic condition is good. The curve number for the cropping season is 67.

Step 5. Follow the same procedure for the fallow portion of the growing season using only the hydrologic soil group.

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[b] Appendix B contains a listing of soil groups and their hydrologic soil cover classification.

[c] A Guide to Hydrologic Analysis using SCS Methods. 1982. Richard H. McCuen. Prentice Hall.

Table 9. Runoff Curve Numbers for Hydrologic Soil-Cover Complexes[a]
(Antecedent Moisture Condition II, and $I_a = 0.2$ S)

Cover			Hydrologic Soil Group			
Land Use	Treatment or Practice	Hydrologic Condition	A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	Straight row	Poor	72	78	85	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
	Contoured and terraced	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
	Straight row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured and terraced	Poor	61	72	79	82
	Contoured and terraced	Good	59	70	78	81
Close-seeded legumes[b] or rotation meadow	Straight row	Poor	66	77	85	89
	Straight row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured and terraced	Poor	63	73	80	83
	Contoured and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads		----	72	82	87	89
(dirt)[c]		----	74	84	90	92
(hard surface)[c]						

[a] Soil Conservation Service, USDA. SCS National Engineering Handbook, Section 4, Hydrology. 1971.

[b] Close-drilled or broadcast.

[c] Including right-of-way.

Table 10. Method for Converting Crop Yields to Residue[a]

Crop[b]	Straw/Grain Ratio	Bushel Weight (lbs)
Barley	1.5	48
Corn	1.0	56
Oats	2.0	32
Rice	1.5	45
Rye	1.5	56
Sorghum	1.0	56
Soybeans	1.5	60
Winter wheat	1.7	60
Spring wheat	1.3	60

[a] Crop residue = (straw/grain ratio) x (bushel weight in lb/bu) x (crop yield in bu/acre).

[b] Knisel, W. G. (Ed.). CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. USDA, Conservation Research Report No. 26, 1980.

Table 11. Residue Remaining From Tillage Operations[a]

Tillage[b] Operation	Residue Remaining (%)
Chisel plow	65
Rod weeder	90
Light disk	70
Heavy disk	30
Moldboard plow	10
Till plant	80
Fluted coulter	90
V Sweep	90

[a] Crop residue remaining = (crop residue from Table 10) x (tillage factor(s)).

[b] Knisel, W. G. (Ed.). CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. USDA, Conservation Research Report No. 26, 1980.

Table 12. Reduction in Runoff Curve Numbers Caused by Conservation Tillage and Residue Management[a]

Large Residue Crop[b] (lb/acre)	Medium Residue Crop[c] (lb/acre)	Surface Covered by Residue (%)	Reduction in Curve Number[d] (%)
0	0	0	0
400	150	10	0
700	300	19	2
1,100	450	28	4
1,500	700	37	6
2,000	950	46	8
2,500	1,200	55	10
6,200	3,500	90	10

[a] Knisel, W. G. (Ed.). CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. USDA, Conservation Research Report No. 26, 1980.

[b] Large-residue crop (corn).

[c] Medium residue crop (wheat, oats, barley, rye, sorghum, soybeans).

[d] Percent reduction in curve numbers can be interpolated linearly. Only apply 0 to 1/2 of these percent reductions to CN's for contouring and terracing practices when they are used in conjunction with conservation tillage.

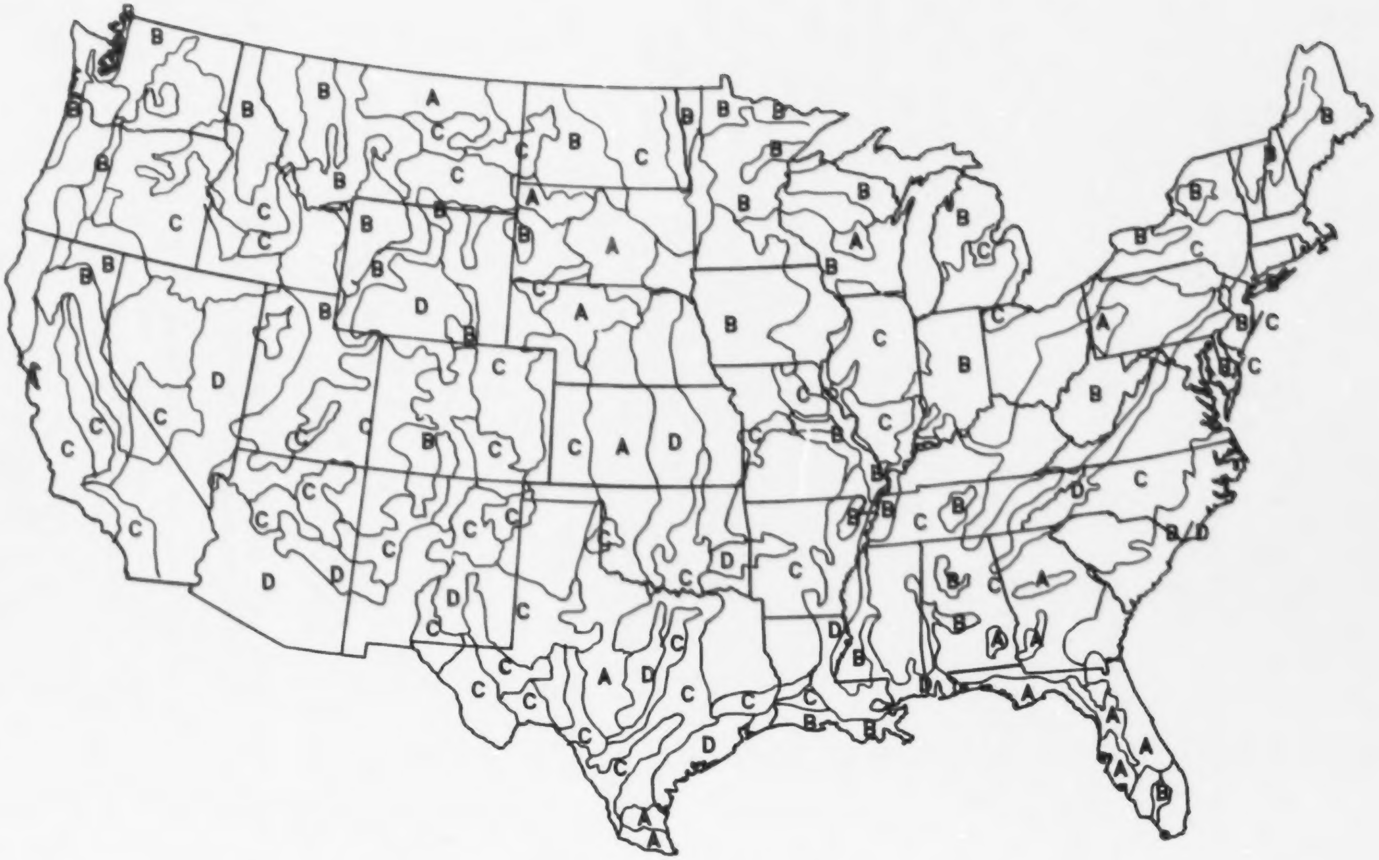

Figure 7. Diagram for estimating Soil Conservation Service soil hydrologic groups. (From EPA Field Guide for Scientific Support Activities Associated with Superfund Emergency Response. U.S. Environmental Protection Agency, Corvallis OR, EPA-600/8-82-025).

Example: Hydrologic soil group A, land use fallow, curve number for condition II is 77.

Step 6. The post-harvest or residue portions of the year requires curve numbers that reflect the extent of surface cover after harvest. This can be quite variable and in many cases may require considerable judgement. Under "average" conditions a value set to the mean of the fallow and growing period numbers (from steps 4, 5) is appropriate. In the example case, this number will be the mean of 77 and 67, or 72.

Step 7. The curve number input sequence is now written as

77 67 72

Additional guidance for management practices

Pesticides are being increasingly used in conjunction with conservation practices to reduce erosion and runoff. Most notable among these practices is the use of conservation tillage. The idea is to increase the soil surface residue and hence reduce erosion and runoff by increasing infiltration. The curve numbers developed in steps 1-7 assume conventional practices and must be further modified to reflect the changes in management. Both the fallow and growing season numbers must be modified. For purposes of this example, assume the corn is produced by using chisel plows rather than the conventional tillage assumed above. The following steps now apply.

Step 8. From Table 10 find the straw/grain ratio for corn, which is 1.0.

Step 9. From Table 10 find the bushel weight of corn, which is 56.

Step 10. From Table 8 find bushel/acre yield of corn, which is 110.

Step 11. Multiply straw/grain ratio * bushel weight * bushel weight/acre = crop residue produced by the crop. For corn, 1.0 x 56 x 110 = 6160.

Step 12. From Table 11 find the tillage practice desired for the crop use site (e.g. chisel plow).

Step 13. Multiply the crop residue determined in step 11 by the tillage factor from step 12 to determine residue remaining, i.e, 6160 x 0.65 = 4004.

Step 14. From Table 12 find the reduction in curve number for AMC II, crop curve number produced from residue remaining after harvest determined in step 12. For corn at 4000 pounds per acre, a 10% reduction in curve number is produced.

Step 15. Determine the curve number for antecedent moisture condition (AMC) II. From Steps 1 - 5, AMC II was 67. 67 * 0.10 = 6.7, which is rounded to 7.0. The modified curve numbers are 67 - 7 = 60 and 77 - 7 = 70.

Step 16. The post-harvest curve number must also now be reduced by averaging the fallow and growing season numbers, that is, 70 and 60 to yield 65.

4.2.8 Maximum Areal Coverage--(COVMAX) Card 7

If the user chooses to proportion the applied pesticide between the plant canopy and the soil surface as a linear function of the ground cover (see FAM parameter, Section 3), then the model estimates the ground cover as the crop grows to some maximum value, COVMAX. The maximum areal coverage (COVMAX) afforded by crop determines the fraction of ground cover afforded by the crop and thus influences the mass of pesticide that reaches the ground from application. Very little information is available on maximum areal coverage. Williams (Pesticide Runoff Simulator, EPA Contract No. 68-01-3840, Office of Pesticide Programs, 1980) has related the fraction of ground cover to the leaf area index of the crop. The ground cover afforded by the crop is estimated with the equation

$$\mathrm{COVMAX} = (2. - \mathrm{ERFC}\ (1.33\ \mathrm{LAI}_{1,m} - 2.))/2.1 \qquad (32)$$

where COVMAX = fraction of ground covered by the plant
LAI = leaf area index of crop, m, on day, l
ERFC = complimentary error function

4.2.9 Maximum Foliar Dry Weight--(WFMAX) Card 7

If the user chooses to have the model estimate the distribution between plants and the soil by an exponential function, then WFMAX must be specified.

The maximum foliar dry weight, WFMAX, of the plant above ground (kg m^{-2}) is the exponent used in the exponential foliar pesticide applica tion model. WFMAX can be estimated using Table 13. Estimates for other crops will require yield information that is available from from USDA crop reporting service.

Table 13. Values for Estimating WFMAX in Exponential Foliar Model

Crop	Yield[a] (Bu/Ac)	Bushel[a] dry wt. (lbs/Bu)	Straw/Grain Ratio	Units Conversion Factor	WFMAX
Corn	110	56	1.0	1.1214×10^{-4}	1.38
Sorghum	62	56	1.0	1.1214×10^{-4}	0.78
Soybeans	35	60	1.5	1.1214×10^{-4}	0.59
Winter wheat	40	60	1.7	1.1214×10^{-4}	0.72

[a] 10-year average.

WFMAX is computed by finding the product of columns 2, 3, and 5, and by multipling this number by the straw/grain ratio (col. 4) plus 1.0. The straw/grain ratio defines the amount of straw associated with the final grain product. Both the straw and grain should be accounted for to determine the maximum weight. Thus, the straw-to-grain ratio should have (1.0) added to it when used to compute WFMAX. An example is provided for barley.

Step 1. Yield, bushel dry wt., and straw/grain ratio for barley are 42.0, 48.0, and 1.5, respectively.

Step 2. WFMAX = Bu/Ac * Lbs/Bu * (straw/grain ratio + 1.) * conversion factor to yield (kg m^{-2}) for PRZM input.

Step 3. Conversion factor = $2.47 \frac{Ac}{ha} * \frac{1 \text{ ha}}{10^4 m^2} * \frac{0.454 \text{ kg}}{Lbs} =$

$$1.1214 \times 10^{-4}.$$

Step 4. WFMAX = $42.0 * 48.0 * (1.5 + 1.0) * 1.1214 \times 10^{-4}$, which equals 0.56.

4.2.9.1 Cropping Information for Emergence, Maturity, and Harvest--(EMD, EMM, IYREM, MAD, MAM, IYRMAT, HAD, HAM, IYRHAR) Card 9

Generalized cropping information including date of emergence (EMD, EMM, IYREM), maturity (MAD, MAM, IYRMAT), and harvest (HAD, HAM, IYRHAR) for eight major crops including corn, soybeans, wheat, tobacco, grain sorghum, potatoes, and peanuts are provided in Table 8. Simulations involving minor crops such as mint, or where site specific information alters the general practices provided, may require consultation with USDA

Handbook No. 283 (Usual Planting and Harvesting Dates) or the local Cooperative Extension Service.

4.3 PESTICIDES

Pesticides can be applied directly to the soil surface, the plant canopy, or to both. Two modeling problems arise when one considers this. First, the initial distribution of the applied pesticide between plant foliage and the soil surface must be estimated. Second, the remaining foliar deposited pesticides then become available for degradation (photolysis) or removal (volatilization, washoff). Recall from Section 3 that two options are available for how one chooses to distribute the applied pesticides (the FAM parameter).

4.3.1 Initial Foliage to Soil Distribution--(FILTRA) Card 13A

The filtration parameter (FILTRA) relates to the equation for partitioning the applied pesticide between the foliage and ground (this applies when FAM = 3). Lassey, K. R. Atmospheric Environment 16(1), 1982, suggest values in the range of 2.3 - 3.3 $m^2\ kg^{-1}$. Miller, C. W. in Proceedings of Symposium, Biological Implications of Radionuclides Released from Nuclear Industries, Vol II, Vienna, 1979, suggested a value of 2.8 $m^2\ kg^{-1}$ for pasture grasses. Most of the variation appears to be due to the vegetation and not the aerosol.

4.3.2 Foliar Washoff Flux--(FEXTRC) Card 13A

Washoff from plant surfaces is modeled using a relationship among rainfall, foliar fraction of applied pesticide, and an extraction coefficient. The parameter (FEXTRC) is the required input parameter to estimate the flux of pesticide washoff. Exact values are varied and depend upon the crop, pesticide properties, and application method. Smith and Carsel (46) suggest 0.10 is suitable for most pesticides.

4.3.3 Foliar Disappearance Rate Constant--(PLDKRT) Card 13A

The degradation of pesticides on plant surfaces is modeled by a simple first-order rate expression. This is a very chemical specific parameter that must be measured. Typical values for selected pesticides are provided in Table 14.

4.3.4 Pesticide Soil-Water Distribution Coefficients

The user can enter directly the distribution coefficient or the model will calculate a value given other pesticide properties. If the parameter KDFLAG is set to a value of 0 (CARD 15), then direct data input is made as the parameter KD (CARD 17A). If KDFLAG is set to 1, however, additional information is required.

Table 14. Degradation Rate Constants of Selected Pesticides on Foliage[a]

Class	Group	Decay Rate ($days^{-1}$)
Organochlorine	Fast (aldrin, dieldrin, ethylan, heptachlor, lindane, methoxychlor).	0.231 - 0.1386
	Slow (chlordane, DDT, endrin, toxaphene).	0.1195 - 0.0510
Organophosphate	Fast (acephate, chlorpyrifos-methyl, cyanophenphos, diazinon, dipterex, ethion, fenitrothion, leptophos, malathion, methidathion, methyl parathion, phorate, phosdrin, phosphamidon, quinalphos, alithion, tokuthion, triazophos, trithion).	0.2772 - 0.3013
	Slow (azinphosmethyl, demeton, dimethoate, EPN, phosalone).	0.1925 - 0.0541
Carbamate	Fast (carbofuran)	0.630
	Slow (carbaryl)	0.1260 - 0.0855
Pyrethroid	(permethrin)	0.0196
Pyridine	(pichloram)	0.0866
Benzoic acid	(dicamba)	0.0745

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[a] Knisel, W. G. (Ed.). CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. USDA, Conservation Research Report No. 26, 1980.

4.3.5 Options for Use in Estimating Distribution Coefficients from Related Input Data--(PCMC, SOL) Card 15A

The fate of pesticides in soil and water is highly dependent on the sorptive characteristics of the compound. Sorptive characteristics affect the physical movement of pesticides significantly. The sorptive properties of pesticides generally correlate well with the organic carbon content of soils. The carbon content of most soils decreases with depth.

The PRZM model allows for estimating the partition coefficient for pesticides with depth from one of three models (8, 27, 28) based on water solubility and corrected for organic carbon. The three models are:

PCMC1 $$\text{Log } K_{oc} = (-0.54 * \text{Log SOL}) + 0.44 \tag{35}$$

where K_{oc} = organic carbon distribution coefficient
SOL = water solubility, mole fraction

PCMC2 $$\text{Log } K_{oc} = 3.64 - (0.55 * \text{Log SOL}) \tag{36}$$

where SOL = water solubility, milligrams liter^{-1}

PCMC3 $$\text{Log } K_{oc} = 4.40 - (0.557 * \text{Log SOL}) \tag{37}$$

where SOL = water solubility, micro moles liter^{-1}

These models are selected by setting PCMC to values of 1, 2, or 3, respectively. These methods were selected because of referenced documentation and provisions for direct use with the most commonly reported physical pesticide parameter, water solubility. The three models used in PRZM for estimating partitioning between soil and water are limited to specific types of pesticides. These equations are best used for pesticides having melting points below 120 °C. Solubilities above these temperatures are affected by crystalline energy and other such physical properties. The three models are not appropriate for pesticides whose solubilities are affected by crystalline energy or other physical properties, and would have a tendency to overestimate the partitioning between soil and water. Of the three models, the first model is for true equilibrium of completely dispersed particles of soil/water concentrations less than 10.0 g l^{-1}. The second and third models are for soil/water concentrations greater than 10.0 g l^{-1} and for short equilibrium periods of 48 hours or less. For most PRZM applications, the first model would be appropriate.

Selected pesticides having properties amenable for use with the water solubility models are provided in Table 15.

The pesticide solubility, SOL, must also be input. Units must be consistent with the model chosen. Table 15 provides pertinent units for the selected pesticides.

Table 15. Physical Characteristics of Selected Pesticides for Use in Development of Partition Coefficients (Using Water Solubility) and Reported Degradation Rate Constants in Soil Root Zone

Chemical	Common Name	Solubility in Water in Water (Temp. 20-25°C) (mg/l)	Mode of Action						Molecular Weight (g)	Reference	Partitioning Model			Degradation Rate Constant in Soil Root Zone (days^{-1})	Reference
			Reference	Insecticide	Herbicide	Fungicide	Nematocide	Acaricide			PCMC1 (mole fraction)	PMCM2 (mg/l)	PCMC3 (um/l)		
Actellic	pirimiphos-methyl	5	a	X					274	b	$3.28x10^{-7}$	5	18		
Alachlor	alachlor	220	b		X				269.9	b	$1.47x10^{-5}$	220	815	.0384	f
Antor	diethatyl ethyl	105	a		X				311.5	c	$6.07x10^{-6}$	105	337	.0099-.0173	g
Aresin	monolinuron	735	a		X				214.6	b	$6.17x10^{-5}$	735	3430		
Balan	benefin	70	b		X				335.3	b	$3.76x10^{-6}$	70	209	0.3349	f
Basalin	fluchloralin	0.7	b		X				355.7	b	$3.55x10^{-8}$	0.7	2	0.0169	f
Baygon	propoxur	2000	a	X					209	b	$1.72x10^{-4}$	2000	9600		
Baygon Meb	plifenate	50	a	X					336.2	d	$2.68x10^{-6}$	50	149		
Bayleton	triadimefon	70	a			X			267.45	d	$4.72x10^{-6}$	70	262		
Baythion	phoxim	7	b	X					298	b	$4.23x10^{-7}$	7	24		
Baythion C	chlorphoxim	1.7	a	X					301.45	d	$1.02x10^{-7}$	1.7	5.6		
Betasan	bensulide	25	c		X				397.5	b	$1.13x10^{-6}$	25	63		
Bromophos	bromophos	40	a	X					366	b	$1.97x10^{-6}$	40	109	.0198	f
Butachlor	butachlor	23	a		X				312	e	$1.33x10^{-6}$	23	74		
Bux	bufencarb	1	b	X					221.3	b	$8.14x10^{-8}$	1.0	5		
Carbamult	promecarb	92	a	X					207	d	$8.01x10^{-6}$	92	444		
Carbyne	barban	11	c		X				258.1	b	$7.70x10^{-7}$	11	43	.0347	g
Chlordimeform	chlordimeform	250	a	X				X	196.7	b	$2.30x10^{-5}$	250	1270		
Chlorfenvinphos	chlorfenvinphos	110	a	X					359.5	b	$5.51x10^{-6}$	110	306	.0055	f
Chloro IPC	chlorpropham	108	b		X				213.7	b	$9.11x10^{-6}$	108	505	.0058-.00267	g
Chlorpyrifos	chlorpyrifos	2	b	X					350.5	b	$1.03x10^{-7}$	2.0	6		
Co-Ral	coumaphos	1.5	b	X					362.8	b	$7.45x10^{-8}$	1.5	4		
Counter	terbufos	15	a	X			X		288	d	$9.38x10^{-7}$	15	52		
DNOC	DNOC	130	a	X	X	X			198.1	b	$1.18x10^{-5}$	130	656		
Dichlorprop	dichlorprop	350	a		X				235	b	$2.68x10^{-5}$	350	1490	.0578-.0866	f
Dimetan	dimetan	30000	b	X					197.3	b	$2.74x10^{-3}$	30000	152000		

Table 15. Physical Characteristics of Selected Pesticides for Use in Development of Partition Coefficients (Using Water Solubility) and Reported Degradation Rate Constants in Soil Root Zone (Continued)

Chemical	Common Name	Solubility in Water in Water (Temp. 20-25°C) (mg/l)	Mode of Action: Reference	Insecticide	Herbicide	Fungicide	Nematocide	Acaricide	Molecular Weight (g)	Reference	Partitioning Model: PCMC1 (mole fraction)	PMCM2 (mg/l)	PCMC3 (um/l)	Degradation Rate Constant in Soil Root Zone (days^{-1})	Reference
Dimethoate	dimethoate	X=25000	a	X					229.1	b	$1.97x10^{-3}$	25000	109000	.0057	
Dinitramine	dinitroamine	1	a		X				322.2	c	$5.60x10^{-8}$	1	3	.0193-.0856	f
Dinoseb	dinoseb	52	c		X				240.2	b	$3.90x10^{-6}$	52	217	.0462-.0231	g
Dazomet	dazomet	1200	b		X	X	X		162.3	b	$1.33x10^{-4}$	1200	7390		
Devrinol	napropamide	73	a		X				271.36		$4.85x10^{-6}$	73	269		
Elocron	dioxacarb	6000	a	X					223	b	$4.85x10^{-4}$	6000	26900	.3465-.0248	f
Evik	ametryn	185	a		X				227	b	$1.47.10^{-5}$	185	815	.0231-.0077	y
Far-Go	triallate	4	b		X				304.6	b	$2.37x10^{-7}$	4	13	.0231-.0713	g
Fongarid	furalaxyl	230	a			X			301	d	$1.38.10^{-5}$	230	764		
Fornothion	formothion	2600	a	X				X	257	b	$1.82x10^{-4}$	2600	10100		
Fuji-one	isoprothiolane	48	a	X		X			290	d	$2.98x10^{-6}$	48	166		
Gardona	tetrachlorvinphos	11	b	X					366	b	$5.42x10^{-7}$	11	30	.1732-.1386	
Gesaran	methoprotryne	320	a		X				271	b	$2.13x10^{-5}$	320	1180		
Goal	oxyfluorfen	0.1	c		X				361.7	c	$4.98x10^{-9}$	0.1	0.3	.0231-.0173	c
Guthion	azinphos-methyl	29	a	X					317.3	b	$1.65x10^{-6}$	29	91	.0533-.0014	f
Hoelon	diclofop methyl	30	a		X				340.9	d	$1.59x10^{-6}$	30	88		
Imidan	phosmet	25	b	X					317.3	b	$1.42x10^{-6}$	25	79		
IPC	propham	250	b		X				179.2	b	$2.51x10^{-5}$	250	1400	.0347-.0116	g
Linuron	linuron	75	a		X				249.1	b	$5.42x10^{-6}$	75	300	.0280-.0039	f
Malathion	malathion	145	a	X					330.4	b	$7.91x10^{-6}$	145	439	2.91-.4152	f
Mecoprop	mecoprop	620	a		X				214.6	b	$5.21x10^{-5}$	620	2890		
MEMC	MEMC	50000	a			X			295	d	$3.05x10^{-3}$	50000	169000		
Merpelan AZ	isocarbamid	13000	a		X				185	d	$1.27x10^{-3}$	13000	70300		
Mesoranil	aziprotryn	75	b		X				225	b	$6.01x10^{-6}$	75	333		
Mesurol	mercaptodimethur	$2.7x10^7$	a	X					225.3	b	2.16	$2.7x10^7$	$1.2x10^8$		

Table 15. Physical Characteristics of Selected Pesticides for Use in Development of Partition Coefficients (Using Water Solubility) and Reported Degradation Rate Constants in Soil Root Zone (Continued)

Chemical	Common Name	Solubility in Water in Water (Temp. 20-25°C) (mg/l)	Mode of Action: Reference	Insecticide	Herbicide	Fungicide	Nematocide	Acaricide	Molecular Weight (g)	Reference	Partitioning Model: PCMC1 (mole fraction)	PMCM2 (mg/l)	PCMC3 (um/l)	Degradation Rate Constant in Soil Root Zone ($days^{-1}$)	Reference
Methomyl	methomyl	58000	a	X					162.2	b	$6.44x10^{-3}$	58000	358000		
Methoxychlor	methoxychlor	0.1	b	X					345.7	b	$5.21x10^{-9}$	0.1	0.3	.0046-.0033	f
Meth-Parathion	methyl Parathion	$\overline{X}$ = 57.5	a	X					263.2	b	$3.94x10^{-6}$	57.5	219	.2207	f
Nemacur	fenamiphos	400	a			X			303	b	$2.38x10^{-5}$	400	1320		
Nortron	ethofumesate	110	a		X				286	d	$6.93x10^{-6}$	110	385		
Orthene	acephate	$6.5x10^5$	b	X					183.2	b	0.06	$6.5x10^5$	3550000		
Oxamyl	oxamyl	$2.8x10^5$	a	X			X	X	219	b	0.023	$2.8x10^5$	1280000		
Parathion	parathion	24	b	X					291.3	b	$1.48x10^{-6}$	24	82	.0354-.0646	f
Patoran	metabromuron	330	a		X				258.9	d	$2.30x10^{-5}$	330	1280	.2962-.0046	f
Phorate	phorate	50	b	X					260.4	b	$3.46x10^{-6}$	50	192	.0234	f
Propachlor	propachlor	580	c		X				211.7	b	$4.94x10^{-5}$	580	2740	.0363-.0040	f
Propanil	propanil	500	c		X				218	b	$4.13x10^{-5}$	500	2290	.0231-.0139	g
Prowl	pendimethalin	0.5	c		X				281.3	c	$3.20x10^{-8}$	0.5	1.8	.693-.231	g
Prynachlor	prynachlor	500	a		X				221.7	b	$4.06x10^{-5}$	500	2260		
Quinalphos	quinalphos	22	a	X				X	298	d	$1.33x10^{-6}$	22	74		
Ronstar	oxadiazon	0.7	b		X				345.23	b	$3.65x10^{-8}$	0.7	2.0		
Sancap	dipropetryn	16	a		X				255.4	b	$1.13x10^{-6}$	16	63		
Semeron	desmetryn	580	a		X				213	b	$4.91x10^{-5}$	580	2720		
Supracide	methidathion	240	a	X				X	302	b	$1.43x10^{-5}$	240	795	.0495-.0108	f
Tachigareu	hymexazol	85000	a			X			99.05	b	0.02	85000	858000		
Temik	aldicarb	6000	a	X			X	X	190.3	b	$5.68x10^{-4}$	6000	31500	.0322-.0116	f
Tolban	profluralin	0.1	a		X				347.3	c	$5.19x10^{-9}$	0.1	0.3	.0049	f
Tordon	picloram	430	c		X				241.5	b	$3.21x10^{-5}$	430	1780	.0354-.0019	f
Toxaphene	toxaphene	3	b	X					413	b	$1.31x10^{-7}$	3	7	.0046	f
Trichlorfon	trichlorfon	120000	a	X					257.35	d	$8.40x10^{-3}$	120000	466000		

Table 15. Physical Characteristics of Selected Pesticides for Use in Development of Partition Coefficients (Using Water Solubility) and Reported Degradation Rate Constants in Soil Root Zone (Continued)

			Mode of Action								Partitioning Model				
Chemical	Common Name	Solubility in Water in Water (Temp. 20-25°C) (mg/l)	Reference	Insecticide	Herbicide	Fungicide	Nematocide	Acaricide	Molecular Weight (g)	Reference	PCMC1 (mole fraction)	PMCM2 (mg/l)	PCMC3 (um/l)	Degradation Rate Constant in Soil Root Zone (days^{-1})	Reference
Trifluralin	trifluralin	24	b		X				335.3	b	1.29×10^{-6}	24	71	.0956-.0026	f
Tsumacide	MTMC	2600	a	X					165	d	2.84×10^{-4}	2600	15800		

Calculations for the Karickhoff and Chiou partitioning equations are:

PCMC1: $\frac{\text{ppm solubility}}{\text{molecular weight (g)}}$ = millimole solubility (MMS)

$\frac{\text{MMS}}{10^3}$ = molar solubility (MS) $\frac{\text{MS}}{\text{55.5 (molar conc. water)}}$ = mole fraction

Chiou: $\frac{\text{ppm solubility}}{\text{molecular weight (g)}}$ = millimole solubility (MMS)

$\frac{\text{MMS}}{10^3} \times 10^6$ = um/l

References

[a]Farm Chemical Handbook, Meister Publishing Company, Willoughby, OH (1981).

[b]Pesticide Manual, issued by the British Crop Protection Council, 1968.

[c]Herbicide Handbook of the Weed Science Society of America, 4th ed. 1979.

[d]Calculations based on information from Farm Chemical Handbook, 1981.

Table 15. Physical Characteristics of Selected Pesticides for Use in Development of Partition Coefficients (Using Water Solubility) and Reported Degradation Rate Constants in Soil Root Zone (Continued)

[e] Analytical Reference Standards and Supplemental Data for Pesticides and Other Organic Compounds, U.S. EPA-600/2-81-011, 1981.

[f] Nash, R. G. 1980. Dissipation Rate of Pesticides from Soils. Chapter 17. IN CREAMS: A Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. W. G. Knisel, ed. USDA Conservation Research Report No. 26. 643 pp.

[g] Control of Water Pollution from Cropland, Vol. I, a manual for guideline development, EPA-600/2-75-026a.

4.3.6 User Specified Distribution Coefficients--(KD) Card 17A

A useful relationship exists between the octanol-water distribution coefficient and the organic carbon distribution coefficient. This relationship can be used when measured soil distribution coefficients are not available, or the pesticides posses crystalline energy properties that would preclude the use of any water solubility models.

The octanol-water distribution coefficient can be used for calculating distribution coefficients for pesticides that posses monomer-associated properties for solubility in water. Karickhoff et al. Water Res. 13, 1979, proposed a relationship to K_{ow} by

$$\log K_{oc} = 1.00\ (\log K_{ow}) - 0.21 \qquad (33)$$

where K_{ow} = octanol-water distribution coefficient
K_{oc} = organic carbon distribution coefficient

Carbofuran is a pesticide that exhibits crystalline energy relationships and its apparent distribution coefficient should be estimated using its log K_{ow}, which is 2.44. Substituting into the Karickhoff equation

$$\log K_{oc} = 1.00\ (2.44) - 0.21 = 2.23$$
$$K_{oc} = 10^{2.23} = 169.8$$

For a soil with 0.5% organic carbon the K_d of the pesticide is

$$K_d = K_{oc} \frac{\text{(percent organic carbon)}}{100} \qquad (34)$$

$$K_d = 169.8\ \frac{(0.5)}{100} = 0.85$$

This compares to an estimated K_d of 2.68 using the PCMC1 water solubility model (Card 15A). Selected pesticides having properties amenable for use with the octanol water distribution model by Karickhoff are provided in Table 16.

4.3.7 Degradation Rate Constants--(DKRATE) Card 17

The processes that contribute to pesticide disappearance in soils are varied and depend on environmental factors as well as chemical properties. Unfortunately, only rarely are process-specific rate constants (e.g., hydrolysis) reported for the soil environment. In most cases, a lumped first-order rate constant is assumed. This is the model used in PRZM. Although such an approximation is imprecise, most modeling efforts follow the same approach and many pesticides appear to behave similarly. For example, Nash (36) found that disappearance of many compounds was highly correlated to a first order approximation with $r^2 \geq 0.80$. More recently, Rao, et al., 1984 (Estimation of Parameters for Modeling The Behavior of Selected Pesticides and Orthophosphate, EPA-

Table 16. Octanol Water Distribution Coefficients (log K_{OW}) and Soil Degradation Rate Constants for Selected Chemicals

Chemical Name	Log K_{OW}^{b}	Degradation Rate Constant (days^{-1})	Reference
Alachlor	2.78	0.0384	a
Aldicarb	0.70	0.0322 - 0.0116	a
Altosid	2.25		
Atrazine	2.45	0.0149 - 0.0063	a
Benomyl	2.42	0.1486 - 0.0023	a
Bifenox	2.24	0.1420	a
Bromacil	2.02		
Captan	2.35		
Carbaryl	2.56	0.1196 - 0.0768	a
Carbofuran	2.44	0.0768 - 0.0079	a
Chloramben	1.11		
Chlordane	4.47	0.0020 - 0.0007	
Chloroacetic Acid	-0.39		
Chloropropham	3.06	0.0058 - 0.00267	d
Chloropyrifos	4.97		
Cyanazine	2.24	0.0495	c
Dalapon	0.76	0.0462 - 0.0231	d
Dialifor	4.69		
Diazinon	3.02	0.0330 - 0.0067	a
Dicamba	0.48	0.2140 - 0.0197	a
Dichlobenil	2.90	0.0116 - 0.0039	
Dichlorofenthion	5.14		
2,4-Dichlorophenoxy-acetic Acid	2.81	0.0693 - 0.0231	d
Dichloropropene	1.73		
Diciofol	3.54		
Dinoseb	2.30	0.0462 - 0.0231	d
Diuron	2.81	0.0035 - 0.0014	d
Endrin	3.21		
Fenitrothion	3.36	0.1155 - 0.0578	a
Fluometuron	1.34	0.0231	c
Linuron	2.19	0.0280 - 0.0039	a
Malathion	2.89	02.91 - 0.4152	a
Methomyl	0.69		
Methoxychlor	5.08	0.0046 - 0.0033	a
Methyl Parathion	3.32	0.2207	a
Monolinuron	1.60		
Monuron	2.12	0.0046 - 0.0020	d
MSMA	-3.10		
Nitrofen	3.10		
Parathion	3.81	0.2961 - 0.0046	a
Permethrin	2.88	0.0396	e
Phorate	2.92	0.0363 - 0.0040	a
Phosalone	4.30		

Table 16. Octanol Water Distribution Coefficients (log K_{OW}) and Soil Degradation Rate Constants for Selected Chemicals (Continued)

Chemical Name	Log K_{OW}[b]	Degradation Rate Constant ($days^{-1}$)	Reference
Phosmet	2.83		
Picloram	0.30	0.0354 - 0.0019	a
Propachlor	1.61	0.0231 - 0.0139	d
Propanil	2.03	0.693 - 0.231	d
Propazine	2.94	0.0035 - 0.0017	d
Propoxur	1.45		
Ronnel	4.88		
Simazine	1.94	0.0539 - 0074	a
Terbacil	1.89		
Terbufos	2.22		
Toxaphene	3.27	0.0046	e
Trifluralin	4.75	0.0956 - 0.0026	a
Zineb	1.78	0.0512	a

[a] Nash, R. G. 1980. Dissipation Rate of Pesticides from Soils. Chapter 17. IN CREAMS: A Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. W. G. Knisel, ed. USDA Conservation Research Report No. 26. 643pp.

[b] Smith, C. N. Partition Coefficients (Log K_{OW}) for Selected Chemicals. Athens Environmental Research Laboratory, Athens, GA. Unpublished report, 1981.

[c] Herbicide Handbook of the Weed Science Society of America, 4th ed. 1979.

[d] Control of Water Pollution from Cropland, Vol. I, a manual for guideline development, EPA-600/2-75-026a.

[e] Smith, C. N. and R. F. Carsel. Foliar Washoff of Pesticides (FWOP) Model: Development and Evaluation. Accepted for publishing in Journal of Environmental Science and Health - Part B. Pesticides, Food Contaminants, and Agricultural Wastes, B 19(3), 1984.

600/3-84-019) reported that pesticide disappearance rate constants in surface horizons of soils (root zone) are reasonably constant across soils. This is encouraging from a modeling standpoint because of the decrease in sensitivity testing required for dissipation rates.

The dissipation rate of pesticides below the root zone, however, is virtually unknown. Several studies have suggested the rate of dissipation decreases with depth; however, no uniform correction factor was suggested between surface/sub-surface rates. First order dissipation rates for selected pesticides in the root zone are tabulated in Tables 15 and 16.

4.3.8 Plant Uptake of Pesticides--(UPTKF) Card 15

The plant uptake efficiency factor (UPTKF) provides for removal of pesticides by plants and is a function of the crop root zone and the interaction of water and chemical properties of the pesticides. Several approaches to modeling the uptake of nutrients/pesticides have been proposed ranging from process models that treat the root system as a distribution sink of known density or strength to empirical approaches that assume a relationship to the transpiration rate. To obtain information on the actual mass of residue removed by the plant, both the concentration of the pesticide and the mass of the plant tissue are required. Unfortunately most studies of plant uptake do not provide the two constituents required for calculation of the mass removed. Dejonckheere, W. et al. Pesti. Sci., 14, 1983, reported the mass of uptake into sugar beets for the pesticides aldicarb and thiofanox for three soils (sandy loam, silt loam, and sandy clay loam). Mass removal expressed as a percentage of applied material for aldicarb on sandy loam, silt loam, and clay loam ranged from 0.46-7.14%, 0.68 - 2.32%, and 0.15 - 0.74%, respectively. For thiofanox, 2.78 - 20.22%, 0.81 - 8.70%, and 0.24 - 2.42% removals were reported for the respective soils. The amount of uptake was higher for sandy soils and increased with available water. Other reviews have suggested ranges from 4 - 20% for removal by plants (23), (37).

The procedure adopted for PRZM estimates the removal of pesticides by plant uptake based on the assumption that uptake of the pesticide is directly related to the transpiration rate. Sensitivity tests conducted indicate an increase in the uptake by plants as the root zone depth increases, and a decrease as the partition coefficient increases. For highly soluble pesticides and for crop root zones less than 120 cm, the modeled uptake varied within the range reported by Dejonckheere, et al. For highly soluble pesticides and for crop root zones of greater than 120 cm, values of greater than 20% were simulated. For initial estimates a value of 1.0 for UPTKF is recommended. If more than 20 - 25% of the pesticide is simulated (to be removed by plant uptake), UPTKF should be calibrated to a value less than 1.0. The uptake efficiency factor is estimated using a procedure from Briggs et al. Pesti. Sci., 13, 1982. According to Briggs, the plant uptake efficiency of pesticides can be described using the equation

$$\text{UPTKF} = 0.784 \exp - [(\log K_{ow} - 1.78)^2/2.44] \tag{38}$$

where UPTKF = plant uptake efficiency factor
K_{ow} = octanol-water distribution coefficient

The uptake efficiency factor UPTKF using the above equation will vary from 0.01-0.80 depending on the pesticide's partitioning capacity. The estimated plant uptake efficiency factor is used to calibrate plant uptake of pesticides when required.

4.3.9 Dispersion--(DISP) Card 17

The dispersion or "smearing out" of the pesticide as it moves down in the soil profile is attributed to a combination of molecular diffusion and hydrodynamic dispersion. The transport equations solved in PRZM also produce truncation error leading to a purely mathematical or numerical dispersion. The terms dropped from the Taylor's series expansion from which the finite difference equations were formulated lead to errors that appear identical to the intentional expressions for hydrodynamic dispersion. For these reasons the DISP parameter must be evaluated in light of both "real" and "numerical" components.

Molecular diffusion, D_m, in soils will be lower than free-water diffusion and has been estimated by Bresler, Water Res. Res. 9(4), 1973, as

$$D_m = D_w \, a e^{b\theta} \tag{39}$$

where D_w = molecular diffusion in free water, $\text{cm}^2 \text{ day}^{-1}$
a = soil constants having a range of 0.001 to 0.005
b = soil constant having an approximate value of 10
θ = volumetric water content, $\text{cm}^3 \text{ cm}^{-3}$

The free-water diffusion coefficient, D_w, can be estimated from procedures outlined by Lyman et al., Research and Development of Methods for Estimating Physicochemical Properties of Organic Compounds of Environmental Concern, U.S. Army Medical Research and Development Command Contract DAMD 17-78-C-8073, 1981. In any case, values are quite low, typically less than 10^{-6} $\text{cm}^2 \text{ day}^{-1}$, and can be ignored.

Hydrodynamic dispersion is more difficult to estimate because of its site-soil specificity and its apparent strong dependence upon water velocity. Most investigators have established an effective diffusion or dispersion coefficient that combines both molecular and hydrodynamic terms. This combined expression can then be related to system variables by developing expressions from field measurements. Most notable among these expressions is

$$D = 0.6 + 2.93 \, v^{1.11} \tag{40}$$

where D = effective dispersion coefficient, $cm^2\ day^{-1}$
v = pore water velocity, $cm\ day^{-1}$

by Biggar and Nielsen, Water Res. Res. 12, 1976. Note in Equation 40 that D is now a time and depth varying function since v is both time and depth-varying. The problem remains to estimate the assumed constant value for DISP, the PRZM effective dispersion coefficient.

As previously noted, the numerical scheme chosen for solution of the transport equation produces numerical dispersion. Indeed, this dispersion is also related to the magnitude of the velocity term. Other variables that influence the truncation error include the time and space steps. Because this dispersion is a function of velocity it is not possible to illustrate the entire range for all anticipated modeling problems. A sensitivity analysis was performed, however, to examine the influence of the spatial step, Δx. Results are given in Figure 8. For these runs the DISP parameter was set to 0.0.

The influence of the DISP parameter superimposed on the numerical dispersion created by the model at a Δx value of 5.0 cm is shown in Figure 9. Clearly, even when moderate values for DISP are used, substantial dispersion is produced. If equation 40 is used along with typical simulated values for velocity (0.1 - 22 cm day^{-1}), then calculated DISP values range from 0.83 - 91 $cm^2\ day^{-1}$. It is clear that if this procedure is used, the desired dispersion will be substantially higher than it should be because of the model's numerical dispersion.

A number of modeling studies were performed to investigate the impact of model parameters other than DISP on the apparent dispersion. From these rather exhaustive studies, the following guidance is offered.

(1) A spatial step or compartment size of 5.0 cm will mimic observed field effective dispersion quite well and should be used as an initial value.

(2) No fewer than 30 compartments should be used in order to minimize mass balance errors created by numerical dispersion.

(3) The DISP parameter should be set to 0.0 unless field data are available for calibration.

(4) If DISP calibration is attempted, the compartment size should be reduced to 1.0 cm to minimize the numerical dispersion.

(5) Equation 37 can be used to bound the values only should the need arise to increase dispersion beyond that produced by the numerical scheme.

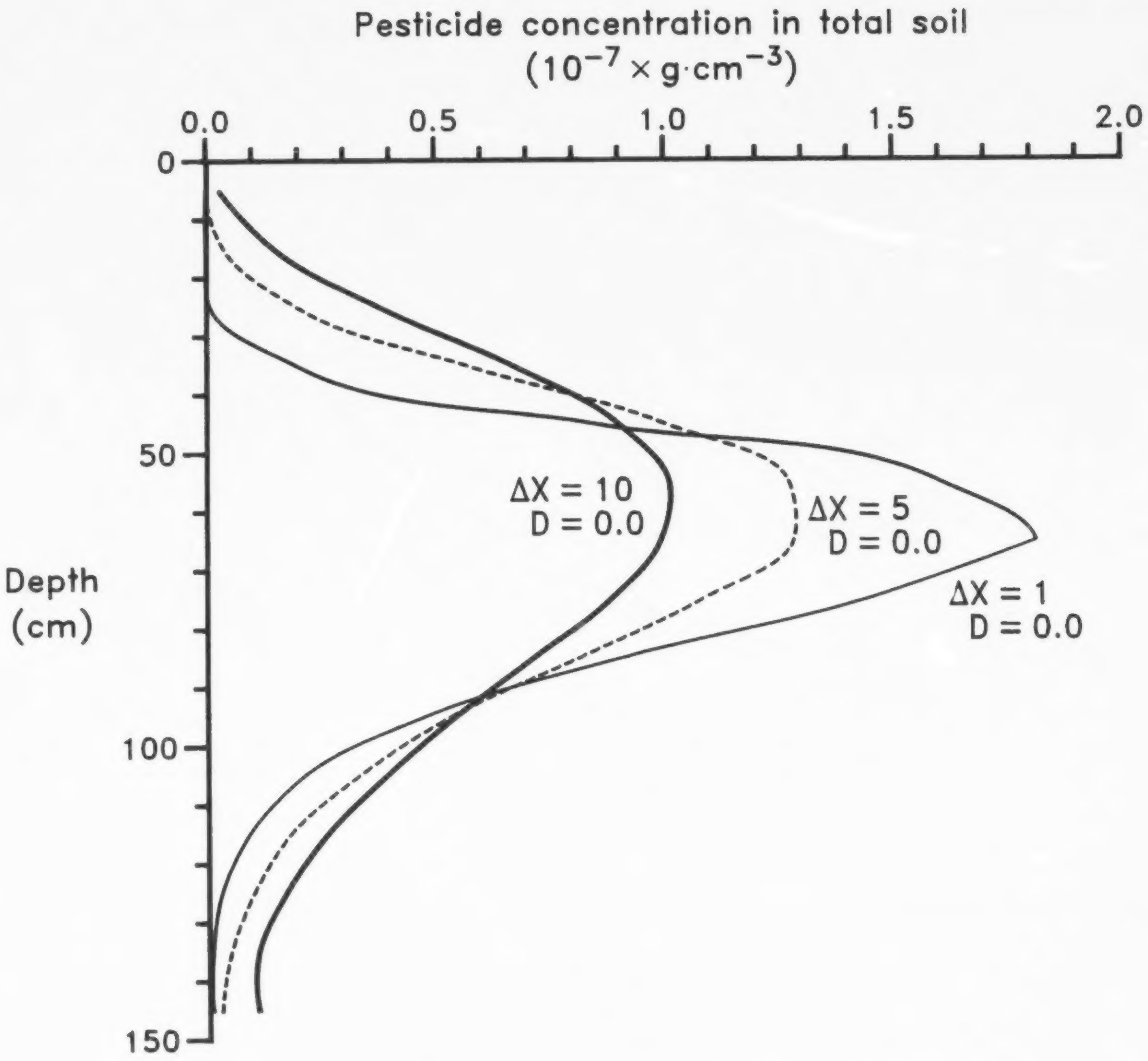

Figure 8. Numerical dispersion associated with space step (ΔX).

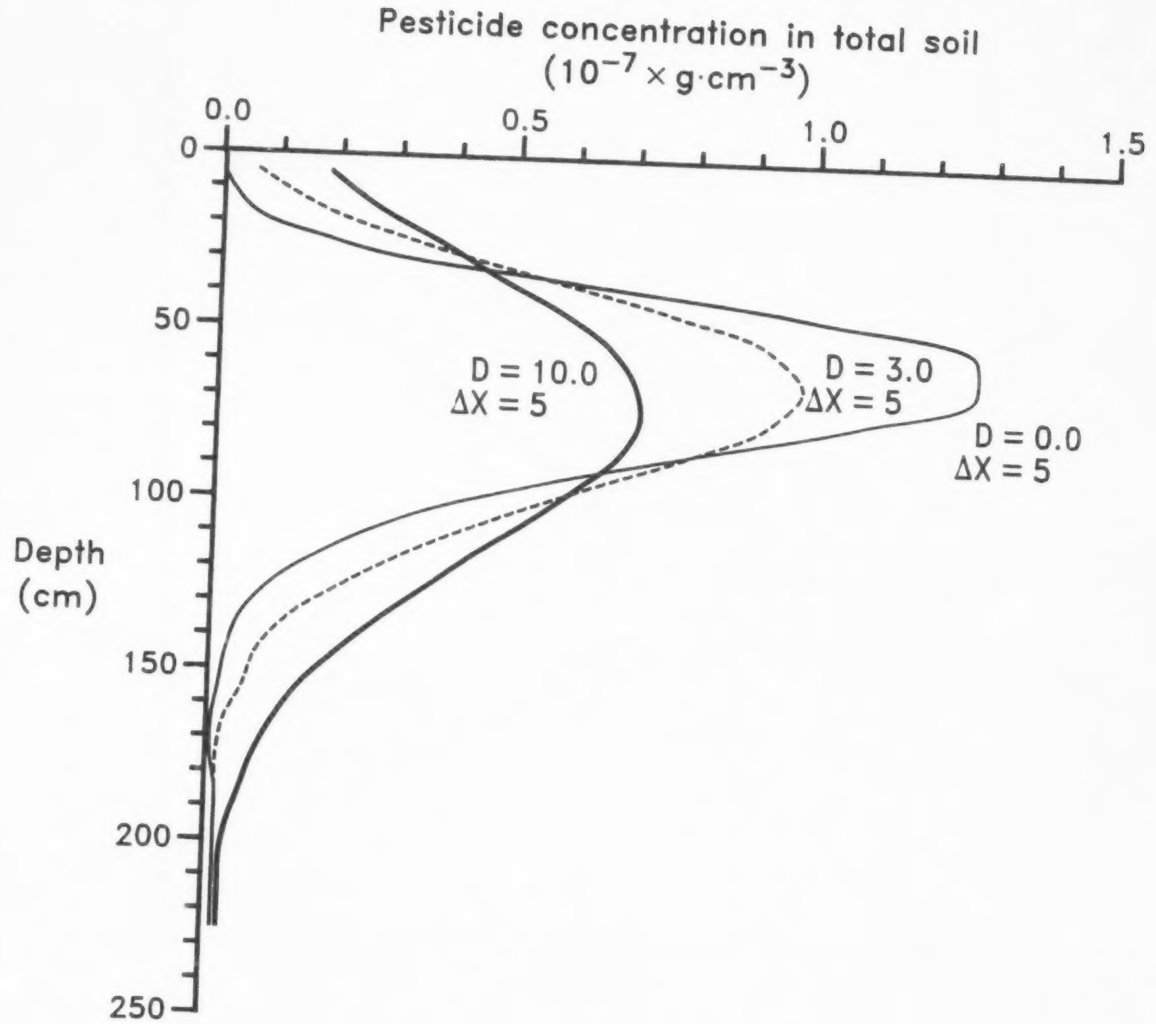

Figure 9. Physical dispersion (D) associated with advective transport. (Note: Numerical dispersion included).

4.3.9.1 Pesticide Application--(APD, APM, IAPYR, DEPI) Card 12

The use of PRZM requires the establishment of a pesticide application procedure. This procedure should be somewhat standardized for the application and distribution forms of a pesticide to minimize the occurrence or likelihood of bias in the selection of pesticide application. The user should follow four steps in establishing a representative application procedure: (1) establish an application period window covering the range of possible application dates; (2) adjust the application dates within the window so that application does not occur on a day immediately before, during, or immediately after a rainfall event (Pesticides should not be applied to a given field with high moisture content or for conditions where the efficacy would be diminished.); (3) select the pesticide mode of application--either aerial or ground sprayer (pre-plant incorporated or pre-plant not incorporated, post emergence and/or foliar)--and the distribution in the soil (surface and/or upper zone); and (4) enter the data for application/distribution into the proper PRZM input file sequence for DEPI. The work by Donigian, A. S., Jr., et al., 1983, (HSPF Parameter Adjustments to Evaluate the Effects of Agricultural Best Management Practices, EPA-600/3-84-066), provides guidance on application methods and soil distribution. An outline of the methodology is provided in Table 17.

4.4 SOILS

The amount of available moisture in the soil is affected by such properties as temperature and humidity, soil texture and structure, organic matter content, and plant characteristics (rooting depth and stage of growth). The moisture content in a soil after "gravity drainage" has ceased is known as field capacity. The moisture content in a soil at which plant survival cannot be achieved and the plant permanently wilts is called the wilting point. The wilting point, which varies among specific soils is influenced by colloidal material and organic matter, but most soils will have a similar wilting point for all common plants.

Soils have a given volume that is unfilled with solid matter and is termed pore space. The proportion of pore space is a function of both the texture and structure of soil (pore space exists between soil grains and aggregates). The amount of pore space is expressed as a fraction, $cm^3\ cm^{-3}$, of the total soil volume. The amount of pore space can vary from horizon to horizon along with other related properties such as bulk density, field capacity, and field saturation. A soil whose pores are essentially filled with water is considered saturated although it is virtually impossible to fill literally every pore in the soil with water. Some residual pore space remains under saturated conditions.

The PRZM model simulates soil water retention in the context of these bulk soil properties. Drainage of "excess water" is simulated as a simple daily value or as a daily rate. Most specific model parameters can be input directly by the user and some can be internally estimated given certain related soil properties as inputs.

Table 17. Pesticide Soil Application Methods and Distribution

Method of Application	Common Procedure	Distribution	DEPI
Broadcast	Spread as dry granules or spray over the whole surface	Remains on the soil surface	0.0
Disked-in	Disking after broadcast application	Assume uniform distribution to tillage depth (10 cm)	10.0
Chisel-plowed	Chisel plowing after broadcast	Assume linear distribution to tillage depth (15 cm)	15.0
Surface banded	Spread as dry granules or a spray over a fraction of the row	Remains on soil surface	0.0
Banded incorporated	Spread as dry granules or a spray over a fraction of the row and incorporated in planting operation	Assume uniform distribution to depth of incorporation (5 cm)	5.0

4.4.1 Moisture Holding Capacity--(THEFC, THEWP) Card 17A

The relationship among soil properties and soil water content is required to model the movement of water and solutes through soils. Field capacity (THEFC) and wilting point (THEWP) are required as direct user inputs. Often these soil-water properties have been characterized and values can be found from soils data bases. Where such data are not available, one of three estimation methods can be used. Method one requires the textural properties (percent sand, silt, and clay), organic matter content (%), and bulk density (g cm^{-3}) of a specific soil. Method two provides a soil triangle matrix for estimating soil water content if only the sand (%) and clay (%) contents are known. Method three provides mean field capacity and wilting points if only the soil texture is known. Eleven soil textures are provided.

Method 1 (also done within the code if THFLAG = 1)

The regression equation from Rawls, W. J. and D. L. Brakensiek. 1982. Estimating Soil Water Retention from Soil Properties. Proc. ASCE, Vol. 108, No. IR2. June. pp 161-171, is used to estimate the matric water potential for various soils:

Equation

$$\theta_x = a + [b \times \mathrm{SAND}(\%)] + (c \times \mathrm{CLAY}(\%)] + [d \times \mathrm{ORGANIC\ MATTER}(\%)] + [e \times \mathrm{BULK\ DENSITY}\ (g\ cm^{-3})] \quad (41)$$

where θ_x = water retention $cm^3\ cm^{-3}$ for a given matric potential (field capacity = -0.33 bar and wilting point = -15.0 bar)

a-e = regression coefficients

Procedure

Step 1. From Table 18 find the matric potential for field capacity and wilting point (-0.33 bar and -15.0 bar).

Step 2. For each matric potential, find the regression coefficients (a-e) that are required in the Rawls and Brakensiek equation (e.g., for -0.33 potential, coefficients a-e are 0.3486, -0.0018, 0.0039, 0.0228, and -0.0738).

Step 3. For any given soil (example: Red Bay Sandy Loam where sand (%), 72.90; clay (%), 13.1; organic matter (%), 0.824; and bulk density (g cm^{-3}), 1.70) solve the equation for the -0.33 and -15.0 potential. We have THEFC = 0.170, THEWP = 0.090.

Method 2

Use Figure 10 for estimating the field capacity and Figure 11 for estimating the wilting point of any soil, given the percent sand and clay.

Step 1. Example: Red Bay Sandy Loam (field capacity). Find the percent sand across the bottom of Figure 10 (i.e., 73.0).

Step 2. Find the percent clay of the soil along the side of the triangle (i.e., 13.0).

Step 3. Locate the point where the two values intersect on the triangle and read the field capacity, THEFC = 0.17.

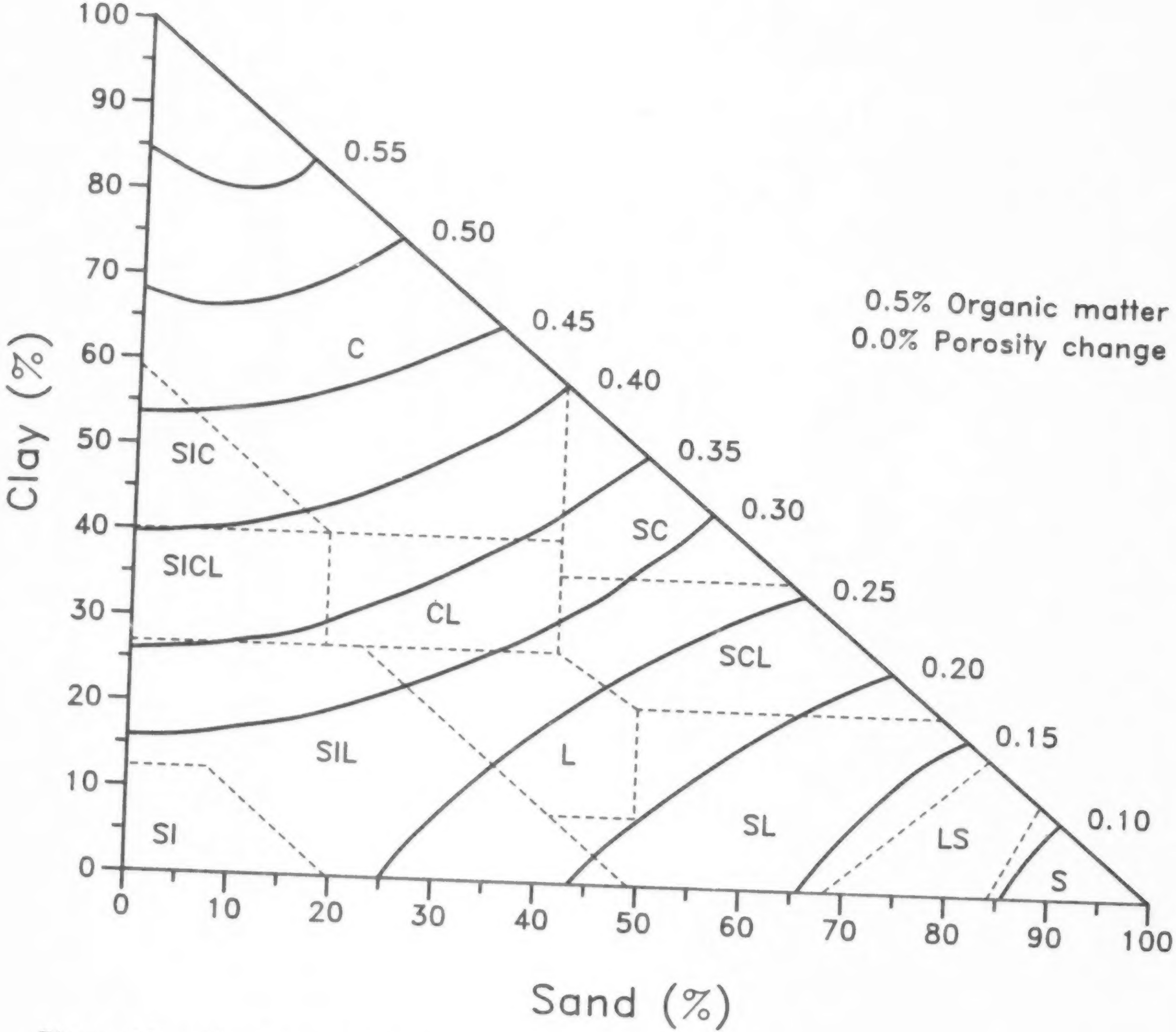

Figure 10. 1/3-Bar soil moisture by volume. (Provided by Dr. Walter J. Rawls, U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland.)

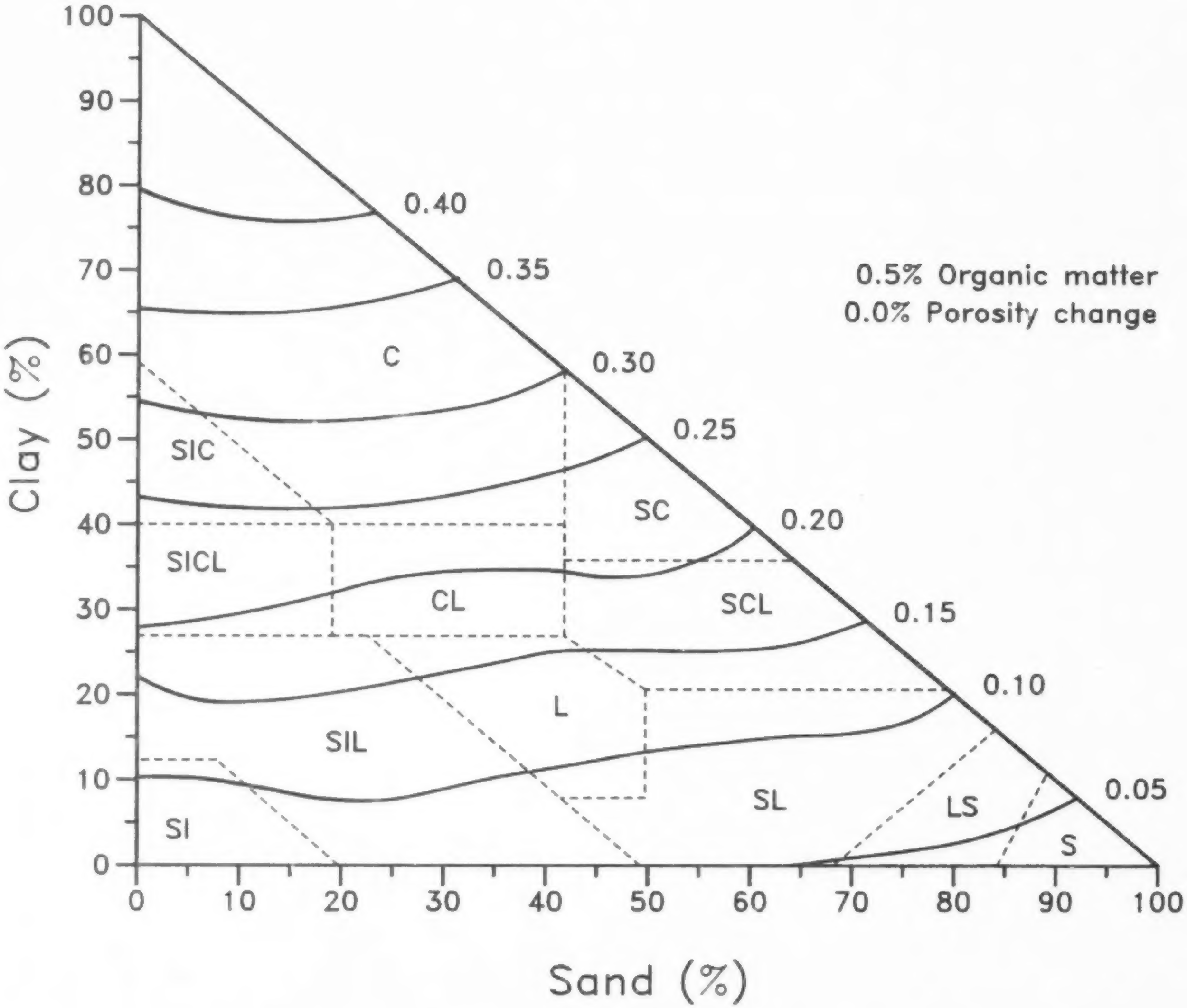

Figure 11. 15-Bar soil moisture by volume. (Provided by Dr. Walter J. Rawls, U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland.)

Step 4. Follow Steps 2-4 for wilting point using Figure 11, THEWP = 0.09.

Method 3

Step 1. Use Table 19 to locate the textural class of the soil of choice.

Step 2. After locating the textural class, read the mean field capacity and wilting point potentials (cm^3 cm^{-3}), to the right of the textural class.

Step 3. Example: Sandy loam. The mean field capacity (THEFC) and wilting point (THEWP) potentials are 0.207 and 0.095, respectively.

Table 18. Coefficients for Linear Regression Equations for Prediction of Soil Water Contents at Specific Matric Potentials[a]

Matric	Intercept	Sand (%)	Clay (%)	Organic Matter (%)	Bulk Density (g cm^{-3})	R^2
Coefficient	a	b	c	d	e	
-0.20	0.4180	-0.0021	0.0035	0.0232	-0.0859	0.75
-0.33	0.3486	-0.0018	0.0039	0.0228	-0.0738	0.78
-0.60	0.2819	-0.0014	0.0042	0.0216	-0.0612	0.78
-1.0	0.2352	-0.0012	0.0043	0.0202	-0.0517	0.76
-2.0	0.1837	-0.0009	0.0044	0.0181	-0.0407	0.74
-4.0	0.1426	-0.0007	0.0045	0.0160	-0.0315	0.71
-7.0	0.1155	-0.0005	0.0045	0.0143	-0.0253	0.69
-10.0	0.1005	-0.0004	0.0044	0.0133	-0.0218	0.67
-15.0	0.0854	-0.0004	0.0044	0.0122	-0.0182	0.66

[a] Rawls, W. J., U. S. Department of Agriculture, Agricultural Research Service, Beltsville, MD. Personal Communication.

Table 19. Hydrologic Properties by Soil Texture[a]

	Range of Textural Properties (Percent)				
Texture Class	Sand	Silt	Clay	Water Retained at -0.33 Bar Tension $cm^3\ cm^{-3}$	Water Retained at -15.0 Bar Tension $cm^3\ cm^{-3}$
Sand	85-100	0-15	0-10	0.091[b] (0.018 - 0.164)[c]	0.033[b] (0.007 - 0.059)[c]
Loamy Sand	70-90	0-30	0-15	0.125 (0.060 - 0.190)	0.055 (0.019 - 0.091)
Sandy Loam	45-85	0-50	0-20	0.207 (0.126 - 0.288)	0.095 (0.031 - 0.159)
Loam	25-50	28-50	8-28	0.270 (0.195 - 0.345)	0.117 (0.069 - 0.165)
Silt Loam	0-50	50-100	0-28	0.330 (0.258 - 0.402)	0.133 (0.078 - 0.188)
Sandy Clay Loam	45-80	0-28	20-35	0.257 (0.186 - 0.324)	0.148 (0.085 - 0.211)
Clay Loam	20-45	15-55	28-50	0.318 (0.250 - 0.386)	0.197 (0.115 - 0.279)
Silty Clay Loam	0-20	40-73	28-40	0.366 (0.304 - 0.428)	0.208 (0.138 - 0.278)
Sandy Clay	45-65	0-20	35-55	0.339 (0.245 - 0.433)	0.239 (0.162 - 0.316)
Silty Clay	0-20	40-60	40-60	0.387 (0.332 - 0.442)	0.250 (0.193 - 0.307)
Clay	0-45	0-40	40-100	0.396 (0.326 - 0.466)	0.272 (0.208 - 0.336)

[a] Rawls, W.J., D.L. Brakensiek, and K.E. Saxton. Estimation of Soil Water Properties. Transactions ASAE Paper No. 81-2510, pgs. 1316 - 1320. 1982.

[b] Mean value.

[c] One standard deviation about the mean.

4.4.2 Bulk Density and Field Saturation--(BD) Card 17

Soil bulk density (BD) is required in the basic chemical transport equations of PRZM and is also used to estimate moisture saturation values. Values for BD are input directly. When such data are not available for the site of interest, methods have been developed for their estimation. Two methods are provided for estimating BD of various soils. Method one requires the textural properties (percent sand, clay, and organic matter). Method two uses mean bulk density values if only the soil texture is known. The following steps provide procedures for estimating bulk density.

Method 1 (Also done within the code if BDFLAG = 1)

A procedure from Rawls, W. O. 1983. Estimating Soil Bulk Density. Soil Science. 135(2). pp 123-125, is used to estimate bulk density for any given soil, provided the percent sand, clay, and organic matter contents are known. Example: Marlboro fine sandy loam--sand 80.0%, clay 5.0%, and organic matter 0.871%.

Equation

$$BD = \frac{100.0}{\frac{\%OM}{OMBD} + \frac{100.0 - \%OM}{MBD}} \tag{42}$$

where BD = soil bulk density, g cm^{-3}
OM = organic matter content of soil, %
$OMBD$ = organic matter bulk density of soil, g cm^{-3} = 0.224
MBD = mineral bulk density, g cm^{-3}

NOTE: MBD must be entered on CARD 17 if BDFLAG = 1.

Step 1. Locate the percent sand (80.0) along the bottom of Figure 12.

Step 2. Locate the percent clay (5.0) along the side of Figure 12.

Step 3. Locate the intersect point of the two values and read the mineral bulk density (1.55).

Step 4. Solve the Rawls equation for BD (e.g., 1.47). If BDFLAG = 1, the mineral bulk density is entered on Card 17 (e.g., 1.55).

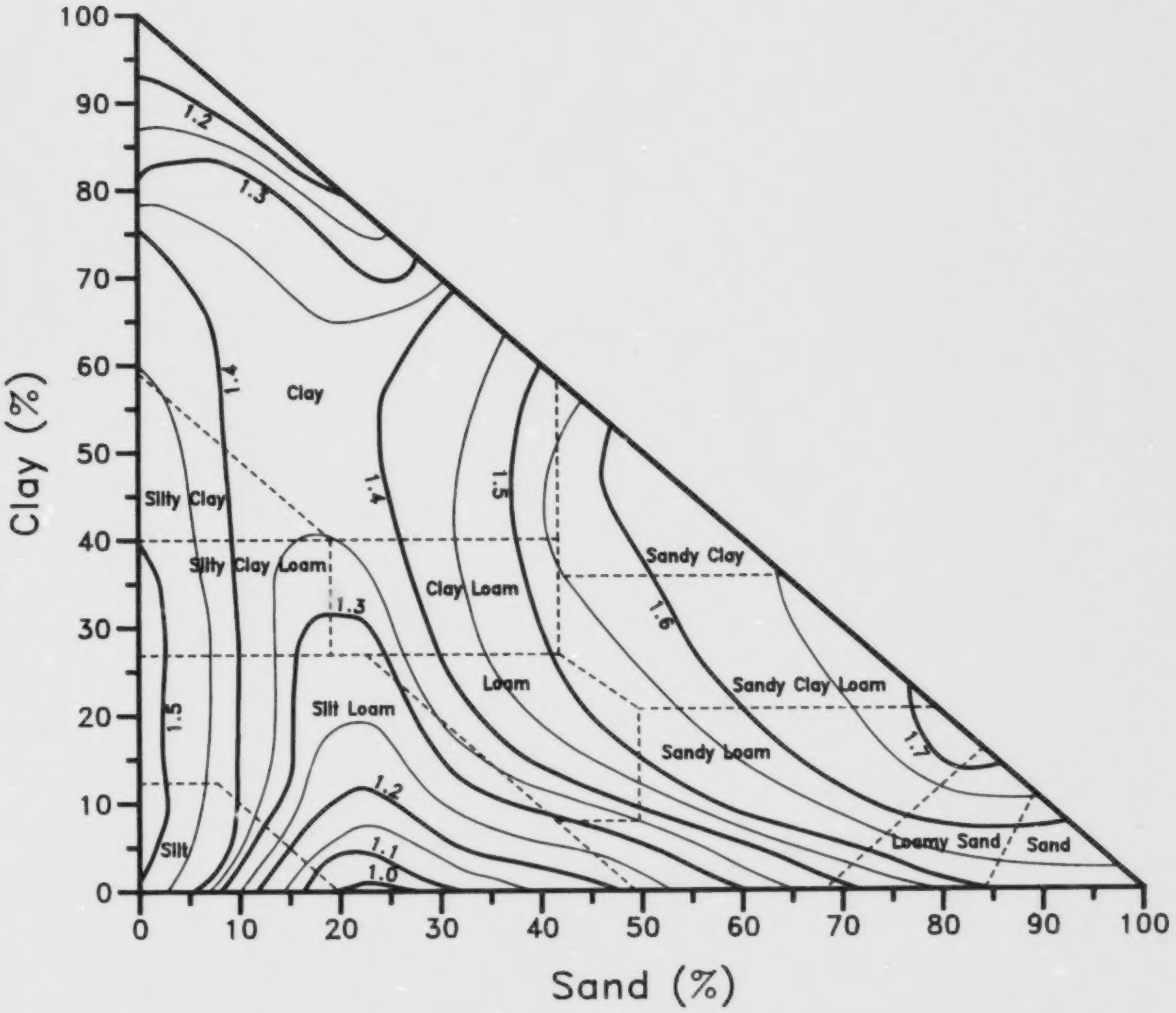

Figure 12. Mineral bulk density (g cm^{-3}). (Provided by Dr. Walter J. Rawls, U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland.)

Method 2

Step 1. Use Table 20 to locate the textural classification of the soil.

Step 2. Read mean bulk density for the general soil texture.

Step 3. Example: Sandy loam. The mean bulk density is 1.49 g cm^{-3}.

Table 20. Mean Bulk Density (g cm^{-3}) for Five Soil Textural Classifications[a]

Soil Texture	Mean Value	Range Reported
Silt Loams	1.32	0.86 - 1.67
Clay and Clay Loams	1.30	0.94 - 1.54
Sandy Loams	1.49	1.25 - 1.76
Gravelly Silt Loams	1.22	1.02 - 1.58
Loams	1.42	1.16 - 1.58
All Soils	1.35	0.86 - 1.76

[a] Baes, C. F., III and R. D. Sharp. 1983. A Proposal for Estimation of Soil Leaching Constants for Use in Assessment Models. J. Environ. Qual. 12(1): 17-28.

4.4.3 Soil Moisture Estimation Technique Problems

PRZM currently is structured to permit ease of operation in providing for direct estimation of input variables for water movement including field capacity, wilting point, bulk density, and field saturation. In certain poorly drained soils (with clay contents in the upper bound of the classification), it is possible that the calculated field capacity may exceed the calculated field saturation values. PRZM will identify such instances. Two options are available if such an error is encountered. The first option is a simple correction by assuming that the saturation value, THETAS, is a constant value in excess of the field capacity. This correction is described by

$$\text{THETAS} = \text{THEFC} + 0.122 \tag{43}$$

The second approach is simply to estimate a corrected value from Table 21.

Should the inconsistency between field capacity and saturation values occur, it will be necessary to make the corrections by adjusting THEFC or BD. Editing the FORTRAN code is another alternative.

4.4.4 Options for Estimating Soil Water Drainage--(HSWZT) Card 15

The HSWZT flag indicates which drainage model is invoked for simulating the movement of recharging water. Drainage model 1 (HSWZT = 0) is for freely draining soils; drainage model 2 (HSWZT = 1) is for more poorly drained soils. For soils with infiltration rates of more than 0.38 cm hr^{-1} (associated with SCS hydrologic soils groups A, B, and some C), setting HSWZT = 0 is recommended. For soils with infiltration rates of less than 0.38 cm hr^{-1} (associated with groups D and some C) setting HSWZT = 1 is recommended.

4.4.5 Soil Water Drainage Rate (for HSWZT = 1)--(AD) Card 17

The drainage rate parameter (AD) used in the HYDR2 hydraulics option of PRZM is an empirical constant and dependent on both soil type and the number of compartments to be simulated. Although there is limited experience using this option, an analysis was performed to determine the best value for AD over a range of soil types on which agricultural crops are commonly grown. Each of three soil types was tested with a constant soil profile depth (125 cm). The profile was divided into a variable number of compartments and the optimum value of AD for each soil/compartment combination was obtained.

The analysis was performed by comparing the storage of water in the soil profile following the infiltration output from SUMATRA-1 (53). This model was used as "truth" because field data were lacking and SUMATRA-1 is theoretically rigorous. The amount of water moving out of the profile changed by only 1 - 2% over the range of compartments tested (15 - 40) for the three soils evaluated. Calibrating PRZM by comparison was accomplished and estimates of AD calculated. Suggested values of AD for clay loam, loamy sand, and sand as a function of the number of compartments are given in Figure 13. This relationship and guidance will be updated as additional experience is gained in its use.

Table 21. Hydrologic Properties by Soil Texture[a]

Texture Class	Residual Porosity (θ_r) $cm^3\ cm^{-3}$	Effective Porosity (θ_e) $cm^3\ cm^{-3}$
Sand	0.020[b] (0.001-0.039)[c]	0.417 (0.354-0.480)
Loamy Sand	0.035 (0.003-0.067)	0.401 (0.329-0.473)
Sandy Loam	0.041 (0.0-0.106)	0.412 (0.283-0.541)
Loam	0.027 (0.0-0.074)	0.434 (0.334-0.534)
Silt Loam	0.015 (0.0-0.058)	0.486 (0.394-0.578)
Sandy Clay Loam	0.068 (0.0-0.237)	0.330 (0.235-0.425)
Clay Loam	0.075 (0.0-0.174)	0.390 (0.279-0.501)
Silty Clay Loam	0.040 (0.0-0.118)	0.432 (0.347-0.517)
Sandy Clay	0.109 (0.0-0.205)	0.321 (0.207-0.435)
Silty Clay	0.056 (0.0-0.136)	0.423 (0.334-0.512)
Clay	0.090 (0.0-0.195)	0.385 (0.269-0.501)

[a] Rawls, W.J., D.L. Brakensiek, and K.E. Saxton. Estimation of Soil Water Properties. Transactions ASAE Paper No. 81-2510, pgs. 1316 - 1320. 1982.

[b] Mean value.

[c] One standard deviation about the mean.

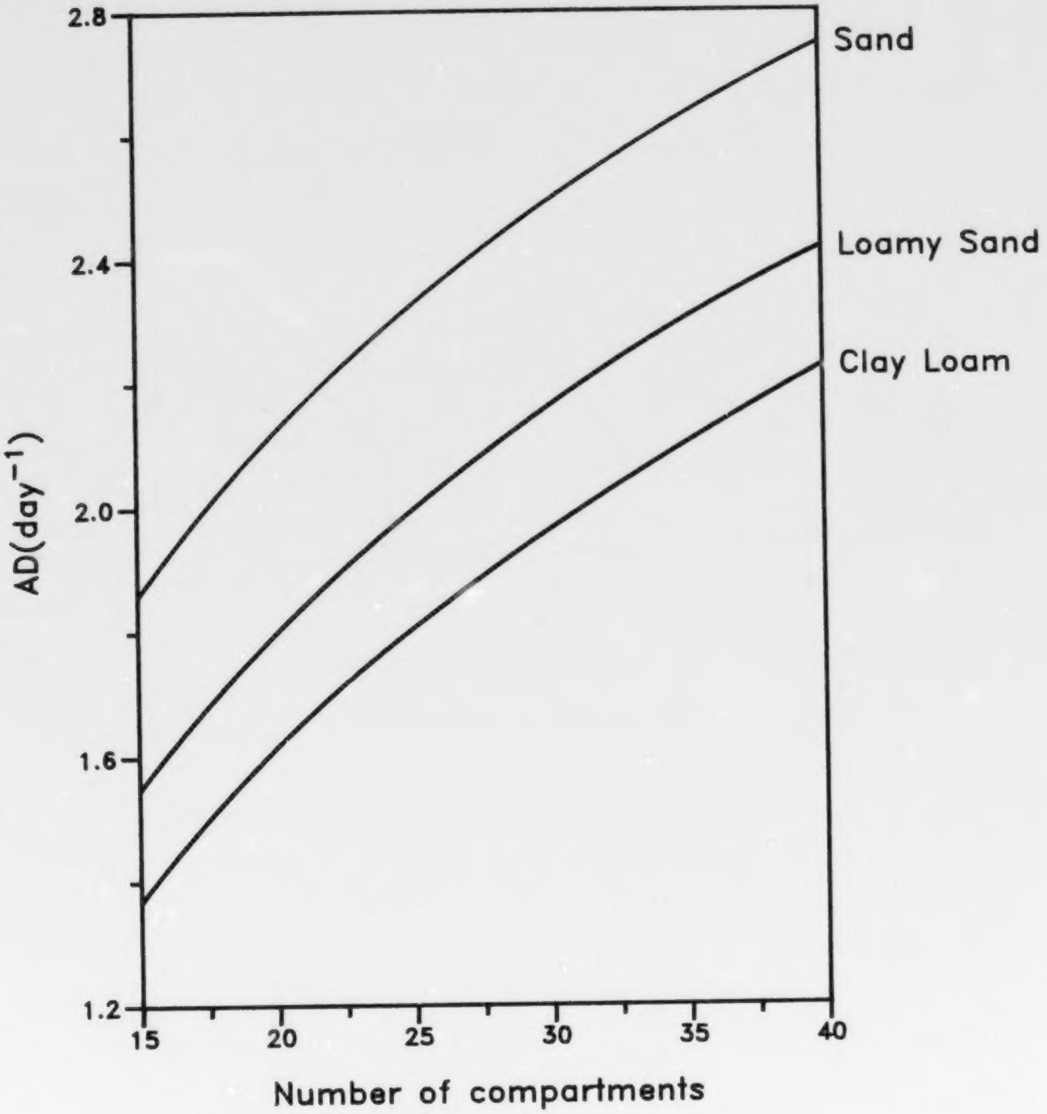

Figure 13. Estimation of drainage rate AD (day^{-1}) versus number of compartments.

SECTION 5

OPERATIONAL MODELING CONSIDERATIONS

5.1 INTRODUCTION

The primary purpose of this guide is to assist users in applying PRZM in evaluations of potential groundwater contamination from pesticide use. Considerable effort was directed towards estimation techniques for many of PRZM's data requirements with the ultimate goal of efficient model utilization. In this chapter, several general modeling considerations that the user should be aware of are described.

A decription of how to obtain the PRZM code and installation on a DEC PDP 11/70 mini computer is also provided.

5.2 AQUISITION PROCEDURES

To obtain the PRZM program along with a sample data set and/or supporting data, write to:

Technology Development & Applications Branch
Attention: PRZM Code Request
Environmental Research Laboratory
U.S. Environmental Protection Agency
College Station Road
Athens, Georgia 30613

A nine-track tape will be mailed to you. The program is designed for a DEC PDP mini computer. Modifications may be required for operation on other machines.

5.3 INSTALLATION PROCEDURES

Among the data sets on the magnetic tape are the subroutines of the modularized PRZM code. These must be compliled and linked into a task image. This is accomplished on the IAS operating system by running the command file "PRZM.BIS," which is listed below:

```
$JOB EPARFE PRZM 999
$!
$!      PRZM.BIS                    DB2:[205,221]               PRZM.BIS
$!
$ON WARNING CONTINUE
$DELETE PRZM.TSK;*
$DELETE PRZM.MAP;*
$DELETE/KEEP PRZM.*
$!
$!
$FORTRAN PRZM
$FORTRAN BLOCKPRZM
$FORTRAN ECHO
$FORTRAN EROSN
$FORTRAN EVPOTR
$FORTRAN FTIME              ! SPECIAL SUBROUTINE ADDED
$FORTRAN HYDR1
$FORTRAN HYDR2
$FORTRAN HYDROL
$FORTRAN INITL
$FORTRAN KDCALC
$FORTRAN MASBAL
$FORTRAN OUTCNC
$FORTRAN OUTHYD
$FORTRAN OUTPST
$FORTRAN OUTTSR
$FORTRAN PESTAP
$FORTRAN PLGROW
$FORTRAN PLPEST
$FORTRAN READ
$FORTRAN SLPEST
$FORTRAN THCALC
$FORTRAN TRDIAG
$!
$!
$ON WARNING GOTO NEXT
$LINK/OPTION/READ/TASK:PRZM/MAP:(PRZM/FULL)/OVERLAY:PRZM
ACTFIL=6
UNITS=10
/
$!
$!
$DELETE PRZM.OBJ;*
$DELETE BLOCKPRZM.OBJ;*
$DELETE ECHO.OBJ;*
$DELETE EROSN.OBJ;*
$DELETE EVPOTR.OBJ;*
$DELETE FTIME.OBJ;*
$DELETE HYDR1.OBJ;*
$DELETE HYDR2.OBJ;*
$DELETE HYDROL.OBJ;*
```

```
$DELETE INITL.OBJ;*
$DELETE KDCALC.OBJ;*
$DELETE MASBAL.OBJ;*
$DELETE OUTCNC.OBJ;*
$DELETE OUTHYD.OBJ;*
$DELETE OUTPST.OBJ;*
$DELETE OUTTSR.OBJ;*
$DELETE PESTAP.OBJ;*
$DELETE PLGROW.OBJ;*
$DELETE PLPEST.OBJ;*
$DELETE READ.OBJ;*
$DELETE SLPEST.OBJ;*
$DELETE THCALC.OBJ;*
$DELETE TRDIAG.OBJ;*
$!
$!
$NEXT: SHOW TIME
$DELETE/KEEP PRZM.*
$DELETE/KEEP BLOCKPRZM.*
$DELETE/KEEP ECHO.*
$DELETE/KEEP EROSN.*
$DELETE/KEEP EVPOTR.*
$DELETE/KEEP FTIME.*
$DELETE/KEEP HYDR1.*
$DELETE/KEEP HYDR2.*
$DELETE/KEEP HYDROL.*
$DELETE/KEEP INITL.*
$DELETE/KEEP KDCALC.*
$DELETE/KEEP MASBAL.*
$DELETE/KEEP OUTCNC.*
$DELETE/KEEP OUTHYD.*
$DELETE/KEEP OUTPST.*
$DELETE/KEEP OUTTSR.*
$DELETE/KEEP PESTAP.*
$DELETE/KEEP PLGROW.*
$DELETE/KEEP PLPEST.*
$DELETE/KEEP READ.*
$DELETE/KEEP SLPEST.*
$DELETE/KEEP THCALC.*
$DELETE/KEEP TRDIAG.*
$!
$!
$DIRECTORY/FULL PRZM.*;*
$EOJ
```

5.4 TESTING PROCEDURES

Once PRZM is installed, the sample input data set should be run and compared with the sample output data set to verify that the program is calculating correctly. An example data set describing an agricultural area in peanut production is provided on the tape (and described in Section 6).

Simulations are run in a batch mode (unless the ANPRZM preprocessor, which is detailed in this section, also is used). To perform a simulation on the PDP, submit the batch input sequence "RUNPRZM," which is listed below:

```
$JOB EPARFE RUNPRZM 9999
$!
$!      This batch file allows you to make a PRZM run by assigning
$!      devices to the proper units. This file also allows you to save
$!      or delete old output files.
$!
$ON WARNING CONTINUE
$!
$!      Delete old data files. (Comment out deletes if old files should
$!      remain)
$DELETE DB1:PRZCN.DAT;*
$DELETE DB1:PRZPS.DAT;*
$DELETE DB1:PRZTS.DAT;*
$DELETE DB1:PRZWT.DAT;*
$!
$!      Assign units to devices. (Strictly for our 11/70 system set up)
$!
$ASSIGN DB2: 2
$ASSIGN DB2: 3
$ASSIGN DB1: 4
$ASSIGN DB1: 7
$ASSIGN DB1: 8
$ASSIGN DB1: 9
$!
$!      Run the PRZM program.
$!
$SHOW TIME
$RUN PRZM
$SHOW TIME
$!
$!      Deassign units to devices. (Strictly for our 11/70 system set
$!      up)
$DEASSIGN 2
$DEASSIGN 3
$DEASSIGN 4
$DEASSIGN 7
$DEASSIGN 8
$DEASSIGN 9
$!
$EOJ
```

5.5 MACHINE LIMITATIONS

Currently, PRZM is set up for the following configurations.

PDP 11/70 Hardware
IAS Operating System
FORTRAN IV

25 parameters
85 constants
50 segments
2 systems

The PDP 11/70 computer utilizing an IAS operating system allocates a 32k word (64 byte) user area for execution of programs. PRZM occupies 45K words of memory. An overlay routine effectively reduces the storage memory to 31K.

A compromise in the size of the program arrays (regulated by the PARAMETER statements at the beginning of the common area) will result in more free area for other applications. Changes to the code should be completely researched and tested.

5.6 ANPRZM: A PRE-PROCESSING MODULE FOR INTERACTIVE MODELING

ANPRZM is a FORTRAN program designed to provide interactive capability for PRZM to create, check, and update input streams of data. ANPRZM was developed to reduce the time and effort required in setting up hydrologic models for calibration/verification/production analyses. ANPRZM also was designed to be helpful to the inexperienced user and yet be efficient for the experienced user. PRZM has a distinct category of input: watershed/pesticide characteristics such as field capacity, wilting point, curve number, crop type, partition coefficient, and decay rate.

For the category of input, ANPRZM provides easy creation of the files by prompting the user for parameters, checking the parameters for agreement to acceptable ranges, and providing default values. The user may decide to change an option within PRZM, which can affect other input required. ANPRZM will provide checks for those type situations, thus saving time from submitting jobs that fail due to missing data. Experience has indicated these types of errors are major sources for extending simulation effort (and frustration).

The code is written in ANSI FORTRAN with coding conventions established and concepts of structured programming used in development.

The code contains utility subroutines and control/logic subroutines. The inputs are by line (provides terminal compatibility). All terminal inputs and outputs are placed in one or small groups of subroutines in order to provide conversion to full screen interaction if desired. The questions are placed in direct access files and are less than 60 characters. Inputs are read as character data with one character per word to provide ease of manipulation by the utility subroutines. Alphanumeric responses use only sufficient characters to distinguish one option from others. Examples are done as "d" or yes as "ye".

For interactive processing, ANPRZM uses a series of questions and answers following a menu in which the response determines the next question for display. The response for any part of the menu may be a series of questions and responses, or, a line format may appear on the screen with entries (changes) at locations beneath the line entered. If ANPRZM is used to update a current simulation run, only selected values to be changed are entered.

When an ANPRZM session is over, the user may go back to another level of the menu. To move to another level the input block (e.g., Soil) is entered.

ANPRZM is best suited for setting up files, checking data input for appropriateness, and for instruction/demonstration using PRZM. If only a single value (such as the curve number for the cropping period) is to be changed, a text editor is more appropriate.

The user is responsible for evaluating whether the model is appropriate for the intended use, the types of data required, the basic components of the model (including files and formats), and what analyses are to be accomplished with the time-series data generated. ANPRZM is not intended to provide artificial intelligence--the cliche "garbage" in "garbage" out still applies.

To complete a simulation using a dynamic hydrologic model such as PRZM, three efforts are required: (1) the input stream for the model must be developed, (2) the climatic data must be placed on a file in the required model format, and (3) time-series output has to be analyzed. ANPRZM reduces the time to accomplish item one of the three efforts required of a simulation with PRZM.

To compile and link the ANPRZM software module, the command file ANPRZM.BIS is run on the IAS operating system, which is listed below.

```
$JOB EPARFE ANPRZM 9999
$!
$!      ANPRZM.BIS                    DB0:[205,221]          ANPRZM.BIS
$!
$ON WARNING CONTINUE
$DELETE ANPRZM.TSK;*
```

```
$DELETE ANPRZM.MAP;*
$!
$FORTRAN ANPRZM
$FORTRAN BLKANPRZM
$FORTRAN CHKINT
$FORTRAN CHKREA
$FORTRAN CHKSTR
$FORTRAN CHRCHR
$FORTRAN CHRDEC
$FORTRAN CHRDIG
$FORTRAN CHRINT
$FORTRAN DATCHK
$FORTRAN DECCHR
$FORTRAN DIGCHR
$FORTRAN FILCHK
$FORTRAN GETTXT
$FORTRAN INTCHR
$FORTRAN JDAY
$FORTRAN JDYDYM
$FORTRAN LENSTR
$FORTRAN MODCRP
$FORTRAN MODHYD
$FORTRAN MODOUT
$FORTRAN MODPST
$FORTRAN MODSOI
$FORTRAN PRNTXT
$FORTRAN PRZFOU
$FORTRAN PRZTIN
$FORTRAN QFLOUT
$FORTRAN QREC
$FORTRAN QRESP
$FORTRAN QRESPM
$FORTRAN READ
$FORTRAN REAOLD
$FORTRAN WRITE
$!
$LINK/OPTION/READ/TASK:ANPRZM/MAP:(ANPRZM/FULL)/OVERLAY:ANPRZM
ACTFIL=4
UNITS=10
/
$!
$DELETE ANPRZM.OBJ;*
$DELETE BLKANPRZM.OBJ;*
$DELETE CHKINT.OBJ;*
$DELETE CHKREA.OBJ;*
$DELETE CHKSTR.OBJ;*
$DELETE CHRCHR.OBJ;*
$DELETE CHRDEC.OBJ;*
$DELETE CHRDIG.OBJ;*
$DELETE CHRINT.OBJ;*
$DELETE DATCHK.OBJ;*
```

```
$DELETE DECCHR.OBJ;*
$DELETE DIGCHR.OBJ;*
$DELETE FILCHK.OBJ;*
$DELETE GETTXT.OBJ;*
$DELETE INTCHR.OBJ;*
$DELETE JDAY.OBJ;*
$DELETE JDYDYM.OBJ;*
$DELETE LENSTR.OBJ;*
$DELETE MODCRP.OBJ;*
$DELETE MODHYD.OBJ;*
$DELETE MODOUT.OBJ;*
$DELETE MODPST.OBJ;*
$DELETE MODSOI.OBJ;*
$DELETE PRNTXT.OBJ;*
$DELETE PRZFOU.OBJ;*
$DELETE PRZTIN.OBJ;*
$DELETE QFLOUT.OBJ;*
$DELETE QREC.OBJ;*
$DELETE QRESP.OBJ;*
$DELETE QRESPM.OBJ;*
$DELETE READ.OBJ;*
$DELETE REAOLD.OBJ;*
$DELETE WRITE.OBJ;*
$!
$DELETE/KEEP ANPRZM.*
$DELETE/KEEP BLKANPRZM.*
$DELETE/KEEP CHKINT.*
$DELETE/KEEP CHKREA.*
$DELETE/KEEP CHKSTR.*
$DELETE/KEEP CHRCHR.*
$DELETE/KEEP CHRDEC.*
$DELETE/KEEP CHRDIG.*
$DELETE/KEEP CHRINT.*
$DELETE/KEEP DATCHK.*
$DELETE/KEEP DECCHR.*
$DELETE/KEEP DIGCHR.*
$DELETE/KEEP FILCHK.*
$DELETE/KEEP GETTXT.*
$DELETE/KEEP INTCHR.*
$DELETE/KEEP JDAY.*
$DELETE/KEEP JDYDYM.*
$DELETE/KEEP LENSTR.*
$DELETE/KEEP MODCRP.*
$DELETE/KEEP MODHYD.*
$DELETE/KEEP MODOUT.*
$DELETE/KEEP MODPST.*
$DELETE/KEEP MODSOI.*
$DELETE/KEEP PRNTXT.*
$DELETE/KEEP PRZFOU.*
$DELETE/KEEP PRZTIN.*
$DELETE/KEEP QFLOUT.*
```

```
$DELETE/KEEP QREC.*
$DELETE/KEEP QRESP.*
$DELETE/KEEP QRESPM.*
$DELETE/KEEP READ.*
$DELETE/KEEP REAOLD.*
$DELETE/KEEP WRITE.*
$!

$DIRECTORY/FULL ANPRZM.*;*
$!
$SRD /SN/LI/FU
$SRD /ST/LI/FU
$!
$EOJ
```

PRZM-compatible ANPRZM is provided with the PRZM distribution tape. Detailed documentation of the code is found in ANNIE - An Interactive Processor for Hydrologic Modeling by Alan M. Lumb and John L. Kittle, Jr., U.S. Geological Survey, Water-Resources Investigations Report. (USGS documentation number not yet assigned).

5.7 USE OF PRZM FOR IRRIGATED AGRICULTURE

PRZM is designed primarily to evaluate pesticide leaching in areas where rainfall is the source of water. It is possible, however, to use the model to evaluate leaching under irrigated systems if special attention is given to the water balance components of the model. In short, if the water balance, including percolation and recharge, is computed properly, the chemical transport or pesticide leaching simulated by PRZM should provide useful results.

In the western United States irrigated crops are a major part of the agriculture water management budget. Water applied as irrigation may evaporate from the soil or crop surface, run off, or leave as leachate. Water applied in excess of crop demand may percolate below the root zone of the crop and carry soluble pesticides with the percolating water. Many irrigated areas may have geologic and soil characteristics that may favor water losses (from excess irrigation) through leachate.

The irrigation requirement is determined from crop ET demand and effective rainfall (water left after runoff and soil storage). Sections 2 and 4 have provided runoff and soil storage requirements for various soils. The average ET demand for various crops in irrigated areas is required for simulation. These data, provided in Table 22, are useful for describing the correct hydrologic response in arid or semi-arid agricultural settings. That is, calibration of the hydrologic component of the model to these values with precipita-

Table 22. Selected Examples of Observed Seasonal Evapotranspiration for Well-Watered, Common Crops in the U.S.A.[a]

Crops	Location	Annual Average Evapotranspiration (cm)
Forage Crops		
Alfalfa	Upham, N.D.	59.4
Alfalfa	Mitchell, Nebr.	74.7
Clover, ladino	Prosser, Wash.	85.9
Alfalfa	Kimberly, Ida.	91.6
Alfalfa	Reno, Nev.	101.3
Alfalfa	Arvin, Calif.	127.5
Alfalfa	Mesa and Tempe, Ariz.	188.7
Grass	Davis, Calif. (Sacramento Valley)	131.6
Grass	Arvin, Calif. (San Joaquin Valley)	130.8
Grass	Thornton, Calif. (Delta)	119.6
Grass	Soledad, Calif. (Salinas Valley)	123.2
Grass	Guadalupe, Calif. (Coastal)	100.6
Grain and Field Crops		
Barley	Powell, Wyo.	38.6
Barley	Mesa, Ariz.	64.3
Barley	Davis, Calif.	38.4
Beans	Powell, Wyo.	39.6
Beans	Redfield, S. Dak.	41.7
Beans	Davis, Calif.	40.4
Corn	Upham, N. Dak.	44.5
Corn	Redfield, S. Dak.	42.2
Corn	Powell, Wyo.	41.4
Corn	Coshocton, Ohio	47.0
Corn	Hot Springs, S. Dak.	53.6
Corn	Bushland, Tex.	61.7
Corn	Davis, Calif.	64.0
Potatoes	Upham, N. Dak.	46.7
Potatoes	Mandan, N. Dak.	45.5
Potatoes	Phoenix, Ariz.	61.7
Rice	Davis, Calif.	92.0
Sorghum	Garden City, Kans.	55.1
Sorghum	Bushland, Tex.	54.9
Sorghum	Mesa, Ariz.	64.5

Table 22. Selected Examples of Observed Seasonal Evapotranspiration for Well-Watered, Common Grain and Field Crops in the U.S.A. (Continued)

Crops	Location	Annual Average Evapotranspiration (cm)
Wheat	Redfield, S. Dak.	41.4
Wheat	Mesa, Ariz.	58.2
Wheat, Mexican	Mesa, Ariz.	65.5
Wheat, winter	Bushland, Tex.	71.9
Sugar Crops		
Sugarbeet	Huntley, Mont.	57.2
Sugarbeet	Redfield, S. Dak.	61.0
Sugarbeet	Kimberly, Ida.	61.7
Sugarbeet	Davis, Calif.	85.1
Sugarbeet	Garden City, Kans.	92.7
Sugarbeet	Bushland, Tex.	99.1
Sugarbeet	Mesa, Ariz.	105.4
Oil Crops		
Castorbean	Mesa, Ariz.	112.8
Safflower	Mesa, Ariz.	115.3
Safflower	Kimberly, Idaho	63.5
Soybean	Redfield, S. Dak.	39.9
Soybean	Mesa, Ariz.	56.4
Fiber Crops		
Cotton	Arvin, Calif.	91.2
Cotton	Mesa and Tempe, Ariz.	104.6
Flax	Redfield, S. Dak.	38.1
Flax	Mesa, Ariz.	79.5
Vegetable Crops		
Broccoli	Mesa, Ariz.	50.0
Cabbage, early	Mesa, Ariz.	43.7
Cabbage, late	Mesa, Ariz.	62.2
Cantaloupe	Mesa, Ariz.	48.5

Table 22. Selected Examples of Observed Seasonal Evapotranspiration for Well-Watered, Common Crops in the U.S.A. (Continued)

Crops	Location	Annual Average Evapotranspiration (cm)
Vegetable Crops (Continued)		
Carrots	Mesa, Ariz.	42.2
Cauliflower	Mesa, Ariz.	47.2
Corn, sweet	Mesa, Ariz.	49.8
Lettuce	Mesa, Ariz.	21.6
Onion, dry	Mesa, Ariz.	59.2
Onion, green	Mesa, Ariz.	44.5
Tomato	Davis, Calif.	68.1

[a]Jensen, M. E. (Ed.). Consumptive Use of Water and Irrigation Requirements. Amer. Soc. Civil Engrs., New York, NY. 1982.

tion inputs changed to irrigation inputs may enable further estimates of leaching. These data should not be used for evapotranspiration demands where rainfall exceeds crop water demands. Bruce et al. (Irrigation of Crops in the Southeastern United States Principles and Practice. USDA publication ARM-S-9/May 1980) provide procedures for plant and soil-water principles to irrigated crops in the Southeastern United States.

5.8 AUXILIARY INFORMATION

The major factors that will determine the success and accuracy of specific site or regional simulations are availability of soils/geologic data and climatological information. Without knowledge of surface/subsurface characteristics (such as water holding capacities) or suitable information from which to estimate such properties, evaluations may be largely conjecture. To establish the correct hydrologic response for site specific or regional simulations, considerable data may be required. These data are not generally collected and aggregated in one central location. The user may spend considerable effort (see Section 6) on developing the input data for model simulations.

In recognition of these limitations several supportive data bases are available with PRZM. The first data base is meteorological information. A search was conducted of reporting weather stations that provide daily precipitation, pan evaporation, and temperature (required PRZM meteorological information) data. A total of approximately 300 stations (having at least 25 years of records) were identified within the continental United States. These records have been assembled onto a disk and an interactive retrival program has been developed to retrieve and assemble the data into PRZM format for use. The second data base consists of generalized soils information assembled from the Soil Conservation Service (Soils Series Investigation Reports) and tabularized onto disk for computer retrival. In addition, the Soil Conservation Service currently has a detailed soils interpretation data base that provides soil/cropping information for some 20,000 soil series. This data base is constantly being updated and is the soils data base recommended for use with PRZM. EPA's Environmental Research Laboratory, Athens, GA, currently provides technology for developing exposure assessment techniques. Several PRZM model application projects have been conducted and one such effort has generated a catalog of 19 major agricultural use areas in the United States with PRZM formatted data input.

This guide is not intended to be a totally stand-alone document for assessing potential ground water contamination--the supporting information required would occupy a guide many times the size of this report. The information/data bases presented here are intended to augment the utility and flexibility of PRZM as well as increase its efficiency to the user.

SECTION 6

SIMULATION STRATEGY

6.1 INTRODUCTION

PRZM application to a specific problem requires development of a simulation plan or strategy. The site must be characterized with regard to meteorologic conditions, soil qualities, and land management practices. Characterization of soils and land management conditions must be developed to define the hydrologic response of the area; pesticide properties determine the behaviour of the chemical. The successful development and implementation of a simulation plan requires completion of five tasks that require varying degrees of effort.

The five tasks and the nominal relative effort required for their completion are: (1) definition of problem, 5%; (2) primary intent description and operational learning curve, 20%; (3) development and input of data set, 40%; (4) calibration and sensitivity analysis, 20%; and documentation and reporting of results, 15%. The degree of effort listed for each specific task is a general indicator only, and each task may vary depending on the specific problem, user experience, and availability of data.

Hydrologic components are similar for an area, but may vary considerably for individual sites within that area. The majority of the PRZM-required hydrologic components have not been deterministically evaluated for individual sites and calibration may be required.

The many climatologic, hydrologic, agronomic, and pesticide characteristics create numerous and diverse scenarios that may have to be investigated when simulating pesticide leaching potential. The use of sensitivity analysis can, however, reduce the number of simulations substantially.

The major emphasis of this section is a discussion of the five steps of a simulation strategy coupled with a demonstration of an example problem, with associated calibration procedures and sensitivity analyses. The guidance presented is not intended to provide the user with a detailed discussion of modeling practices.

6.2 DEFINITION OF EXAMPLE PROBLEM

A systemic pesticide has been found to be effective against a root disease in peanuts. The disease is predominant in the young emerging plant and application has to be made at the time of planting or shortly afterward (up to one month after planting). The expected use of the chemical will be immediate and extensive. The chemical has a water solubility of (800 mg/l at 20°C), possesses a decay rate of 0.0134 $days^{-1}$, and has a distribution coefficient of 0.8 l/mg for soils with 0.50% organic carbon. Concern has been expressed regarding its leaching potential and possible groundwater contamination. A detailed exposure assessment of the likelihood that it would reach groundwater is required.

6.3 PRIMARY INTENT DESCRIPTION/OPERATIONAL LEARNING CURVE

The second step in developing a simulation strategy (after defining the problem) is to develop the primary intent for the evaluation. The primary intent may just be a rapid screening assessment that would involve minimal data gathering and very few simulations. If the intent is to provide frequency durations and probability curves, however, the primary intent will encompass a detailed effort involving intensive data gathering and several simulations. The primary intent process can be divided into three categories:

1. Identify components that must be addressed with the model application and determine the level of detail required to analyze the components identified.

2. Review available (supporting) data and their appropriateness to the modeling components identified.

3. Estimate the time and resources that are required for the assessment.

The quality of modeling results reflect the quality of the data used to apply the model. If the data used to characterize the area are accurate and comprehensive, a higher degree of confidence in model representation of the study area is obtained. A good comparison between simulated and observed values (if available) indicates the model is adequately representing the critical processess in the study area.

PRZM is a new model, with several applications either in progress or completed; consequently, information on resources associated with model application is limited to a few pilot studies. The model does include a fairly comprehensive data base, and time and resources required for an evaluation are minimized.

6.4 DEVELOPMENT OF INPUT DATA SET

For the purposes of PRZM, the simulated hectare parcel of land represents a homogeneous hydrologic response, that is, all of the land in the simulation would exhibit similar properties.

The example crop provided is peanuts. The first step would be to locate the major growing areas for peanuts. Agricultural statistics from the U.S. Department of Agriculture (USDA) show that Florida, Alabama, and Georgia produce most of the nation's peanuts. Georgia produces 61% of the acreage alone. For demonstration of leaching potential, Georgia is chosen for an example location. The USDA Statistical Reporting Service and the Georgia Crop Reporting Service was consulted to identify major peanut growing areas in Georgia. The Dougherty Plain area is an indicated heavy production area.

The topography of the Dougherty Plain is characterized by relatively level or gently undulating land area where altitudes range from 210 to 222 feet. Approximately 80% of the area is used for agriculture. Soils were formed from four geologic sources--the Ocala Limestone, the Flint River, and the McBean and Wilcox formations--all of which were deposited in the tertiary age followed by more recent alluvium deposits. A large peanut growing area is in the southwest section where extensive formations of the Ocala Limestone and Flint River occur with typical soils falling into Tifton, Greenville, Orangeburg, Red Bay, Grady, Faceville, Marlboro, and Norfolk series (SCS Athens, GA. 1983).

The area is characterized by a warm, humid climate with long, hot summers and short mild winters. Rainfall averages 127 cm a year with evapotranspiration running 60 to 80 cm per year. The soils are mostly level to gently sloping (0 - 2% slopes) with the water table several feet below the surface. Flooding does not occur and drainage is good (SCS, Athens, GA. 1983). Runoff potential is low (15-20 cm per year). For demonstration, the widespread Norfolk sandy loam will be used.

Typical soil profiles for Norfolk sandy loam are provided in Table 23.

Peanuts are usually planted from April to May and harvested in mid October to early November. The crop is shallow rooted with 30 to 60 cm typical of the crop. Modified tillage consists of spring moldboard plowing (15 cm), disking, planting, and not cultivating.

Dates of tillage and application of pesticide are provided in Table 24.

A card sequence for the example problem is developed. For some of the parameters where interpretation or further elaboration is required, the logic used in estimating the parameter is provided.

Table 23. Soil Properties for Norfolk Sandy Loam[a]

Depth (cm)	Textural Properties Percent				Moisture Potential					
	Sand	Silt	Clay	OC	Field Capacity cm^3	Wilting Point cm^3	pH	Bulk Density $g\ cm^3$	Hydrologic Class	Drainage
0 - 17	86.0	10.0	4.0	0.54	11.0	1.2	6.3	1.68	B	GOOD
17 - 30	75.0	14.2	10.8	0.22	10.9	3.6	5.5	1.76		
30 - 40	65.4	14.8	19.8	0.25	14.9	5.8	4.8	1.68		
40 - 58	68.7	12.2	19.1	0.10	14.2	9.4	5.3	1.62		
58 - 60	71.5	11.3	18.2	0.11	14.3	8.8	5.4	1.58		
76 - 100	69.0	10.5	20.5	0.04	15.0	9.8	5.0	1.73		
100 - 135	58.5	12.0	29.5	0.04	17.0	12.5	4.8	1.74		

[a] mean of several reported series from SCS

Table 24. Tillage Operations for Continuous Peanuts

Date Each Year	Field Operation[a]	Pesticide Rate ($kg\ ha^{-1}$)	Crop Yield ($lbs\ A^{-1}$)	Crop Factor
March 1	Moldboard Plow			
March 28	Disk			
April 1	Plant/Apply Pesticide	2.0		
April 10	Plant Emergence			
Nov. 1	Harvest Crop		2550	1.5

[a] Assumes modified tillage with continuous peanuts.

CARD SEQUENCE

CARD COLUMN

```
123456789012345678921234567893123456789412345678951234567896123456789712345
67898
```

[CARD 1.0: TITLE (FORMAT 20A4)]

```
SIMULATION PEANUTS - GEORGIA
```

[CARD 2.0: BEGINNING AND ENDING DATE(S) OF SIMULATION (FORMAT 2x, 3I2, 10x, 3I2)]

```
  010150         311277
```

[CARD 3.0: HTITLE (FORMAT 20A4)]

```
-------------    HYDROLOGY PARAMTERS    -------------
```

[CARD 4.0: PAN AND SNOW FACTORS, PAN FLAG, EVAPORATION DEPTH, INITIAL CROP, SURFACE CONDITION INITIAL CROP AFTER HARVEST (FORMAT 2F8.0, I8, F8.0, 2I8)]

```
    0.75   0.457       0    25.0       1       3
```

CARD 4: Pan factor, snow factor, depth of soil evaporation, initial crop and surface condition

The pan factor (PFAC) is used to convert daily pan evaporation into daily potential evapotranspiration. The Dougherty Plain is located in the southwestern corner of Georgia. From Figure 4 the isopleth transecting this section of Georgia is 75. PFAC is reported as a percentage (required in fractional form in the model) and 0.75 is entered for PFAC.

The snow factor (SFAC) is used in the snow algorithm for estimating the amount of snow accumulated or melted. The National Oceanic and Atmospheric Administration provides climatic records for the United States. The Dougherty Plain averages less than 2.0 cm snow/year accumulation. Snow accumulation will not be a predominant part of the water budget. The mean value of 0.457 provided from Section 4 is entered for SFAC.

The amount of water evaporated from the soil surface is governed by a user specified depth (ANETD). From Figure 5, a range of 20-30 cm is provided and a mean of 25.0 cm is estimated and entered for ANETD.

The initial crop (INICRP) and surface condition (ISCOND) are required if the first day of simulation is before the first day of crop emergence (a condition that is met in the Dougherty Plain example). Because only one crop is simulated, INICRP = 1. The surface condition after harvest is either cropping, fallow, or residue (with corresponding values of 1, 2, or 3); for the Dougherty Plain the residue condition exists and 3 is entered for ISCOND.

[CARD 5.0: EROSION FLAG (FORMAT I8)]

```
       0
```

CARD 5: Erosion flag (ERFLAG)

The erosion flag is set equal to zero because the partition coefficient is less than 5.0 as suggested in Section 4.

[CARD 6.0: NUMBER OF DIFFERENT CROPS (FORMAT I8)]

```
       1
```

[CARD 7.0: CROP NUMBER, INTERCEPTION STORAGE, MAXIMUM ROOT DEPTH, MAXIMUM AREAL COVERAGE, SURFACE CONDITION AFTER HARVEST, RUNOFF CURVE NUMBER (AMC II), USLEC, WFMAX (FORMAT I8, 3F8.0, I8, 3(1x, I3), 3(1x, F3.0), F8.0)]

CARD COLUMN

```
12345678901234567892123456789312345678941234567895123456789612345678971234567898

       1    0.05    45.0    85.0       3  86  78  82   0   0  NOTE: USLEC
                                                               and WFMAX
                                                               not required
```

CARD 7: Interception storage, maximum active root depth, maximum areal coverage, surface condition after harvest and runoff curve numbers for fallow, cropping, and residue fraction of the growing season.

The crop interception storage (CINTCP) is the amount of water a plant canopy can retain before through-fall occurs. For peanuts, a range of 0.0 to 0.15 cm is provided from Table 7. Because most crops never obtain maximum density, the value estimated will be less than maximum and 0.05 is estimated and entered for CINTCP.

The maximum active crop rooting depth (AMXDR) is a measure of penetration of the active fraction of the total crop rooting depth. From Table 8, a range of 30 to 60 cm is provided and a mean of 45.0 cm is estimated and entered for AMXDR.

The maximum areal coverage (COVMAX) is the amount of ground cover afforded by the crop. Very little information is available on cover afforded by crops and Equation 32 provided by Williams in Section 4 is used to estimate the ground cover from a similar row crop, soybeans. The equation requires the Leaf Area Index of the crop and from CREAMS (29) a value of 3.00 is provided. By substituting into the Williams equation, a value of 0.95 (or 95%) is estimated. This value is for a somewhat ideal growing crop; therefore, 0.85 is estimated to reflect non-ideal conditions and entered for COVMAX as a percentage, 85.

The surface condition after harvest (ICNAH) is a reflection of the management practices that are conducted for the crop and are either cropping, fallow, and/or residue (with corresponding values of 1, 2, or 3); for peanuts, the residue value of 3 is entered for ICNAH.

The curve numbers (CN) associated with the simulation are a reflection of soil type, land treatment activities, and management practices. Peanuts are row crops grown in straight rows on soils that are in good hydrologic condition. The Norfolk sandy loam soil has a hydrologic class of B and is in good hydrologic condition. A curve number of 78 is estimated for peanuts during the cropping season from Table 9. A curve number of 86 is estimated for the fallow condition during the growing season. The residue condition is a reflection of the amount of plant residue remaining on the ground after harvest. For peanuts, less than 50% of the ground is covered. The CREAMS manual (29) suggests, for residue coverage of 33%, that the curve numbers from the fallow and cropping condition be averaged to estimate the residue curve number. For the Dougherty Plain, 82 is estimated. The three curve numbers are entered for CN fallow, cropping, and residue.

[CARD 8.0: NUMBER OF CROPPING PERIODS (FORMAT I8)]

```
      28
```

CARD 8: Number of cropping periods (NCPDS)

This is simply the inclusive time between the starting and ending date of the simulation and 1977 - 1950 = 28.

[CARD 9.0: DAY, MONTH, YEAR CROP EMERGENCE; DAY, MONTH, YEAR CROP MATURATION; DAY, MONTH, YEAR CROP HARVEST; CROP NUMBER GROWING IN CURRENT PERIOD (FORMAT 2x, 3I2, 2x, 3I2, 2x, 3I2, I8)]

```
  100450  201050  011150       1
  100451  201051  011151       1
  100452  201052  011152       1
  100453  201053  011153       1
  100454  201054  011154       1
  100455  201055  011155       1
```

```
100456  201056  011156        1
100457  201057  011157        1
100458  201058  011158        1
100459  201059  011159        1
100460  201060  011160        1
100461  201061  011161        1
100462  201062  011162        1
100463  201063  011163        1
100464  201064  011164        1
100465  201065  011165        1
100466  201066  011166        1
100467  201067  011167        1
100468  201068  011168        1
100469  201069  011169        1
100470  201070  011170        1
100471  201071  011171        1
100472  201072  011172        1
100473  201073  011173        1
100474  201074  011174        1
100475  201075  011175        1
100476  201076  011176        1
100477  201077  011177        1
```

[CARD 10.0: PTITLE (FORMAT 20A4)]

```
-----------------------    PESTICIDE PROPERTIES    -------------------
```

[CARD 11.0: NUMBER OF APPLICATIONS (FORMAT I8)]

```
      28
```

[CARD 12.0: DAY, MONTH, YEAR OF APPLICATION; RATE OF APPLICATION; DEPTH OF INCORPORATION (FORMAT 2x, 3I2, 2F8.0)]

CARD COLUMN

```
12345678901234567892123456789312345678941234567895123456789612345678971234567898
```

```
  010450      2.0      5.0
  010451      2.0      5.0
  020452      2.0      5.0
  010453      2.0      5.0
  010454      2.0      5.0
  010455      2.0      5.0
  010456      2.0      5.0
  210457      2.0      5.0
  010458      2.0      5.0
  060459      2.0      5.0
  160460      2.0      5.0
  250461      2.0      5.0
```

NOTE: Typical application April 1, deviation is a reflection of rainfall on or near April 1.

```
240462      2.0      5.0
010463      2.0      5.0
010464      2.0      5.0
120465      2.0      5.0
010466      2.0      5.0
010467      2.0      5.0
010468      2.0      5.0
010469      2.0      5.0
170470      2.0      5.0
010471      2.0      5.0
010472      2.0      5.0
160473      2.0      5.0
210474      2.0      5.0
070475      2.0      5.0
050476      2.0      5.0
110477      2.0      5.0
```

CARD 12: Pesticide application timing and incorporation

The timing of pesticide application (APD) is a reflection of rainfall, soil moisture, and label/management recommendations. Estimating the timing of pesticide application involves evaluating the rainfall record for days when the soil moisture is suitable for a tractor or other equipment to operate in the field and to maintain proper management practices. The guidance essentially indicates not to apply the pesticide just before, during, or immediately after a rainfall event.

The depth of incorporation (DEPI) is a function of the pesticides formulation and management. The pesticide used in the Dougherty Plain is a granular formulation incorporated at the time of planting. The guidance provided from Table 17, suggests that a depth of 5 cm is appropriate for this type of application.

[CARD 13.0: PESTICIDE APPLICATION MODEL (FORMAT I8)]

```
       1
```

[CARD 14.0: STITLE (FORMAT 20A4)]

----------------------- SOIL PROPERTIES -------------------------

[CARD 15.0: CORE DEPTH, UPTAKE EFFICIENCY FACTOR, NUMBER OF COMPARTMENTS, BULK DENSITY, THETA, PARTITION FLAGS, AND SOIL HYDRAULICS (FORMAT 2F8.0, 5I8)]

```
   165.0     1.0      33      0       0       0       0
```

CARD 15: Core depth, uptake efficiency factor and number of compartments

The core depth (CORED) is a reflection of the depth from land surface to the top of the water table and is highly variable from area to area. Because most pesticides have been found in superficial aquifers, a core depth of 300 cm or less is recommended.

The uptake efficiency factor (UPTKF) is an estimate of the mass of pesticide taken by the plant in relation to its transpiration rate. For initial estimates, it is assumed that the uptake is equal to the transpiration rate, and a value of 1.0 is entered for UPTKF. (Equation 38 by Briggs (section 4.3.8) could be used initially.)

The number of compartments (NCOM2) reflects accuracy in the numerical technique, array dimensioning, and computer run time (the more compartments the higher the dimensioning and run time). In Section 4, 30 was suggested as a minimum. A total of 33 is entered for CORED.

[CARD 16.0: NUMBER OF HORIZONS (FORMAT I8)]

4

CARD 16: Number of horizons

The actual number of horizons (NHORIZ) in a soil profile are determined by guidelines established within the Soil Conservation Service. The goal in modeling is to combine, when possible, similar horizons without changing a predominant characteristic, such as a clay lens, for efficiency of data input. The first horizon is generally the plow zone and its depth controls where runoff is estimated. The plow zone in the Dougherty Plain is 15 cm and corresponds to horizon 1. The next step is to locate similar soil horizons with properties that can be combined (averaged) for simulation. The (17 -30, 30 - 40), (40 - 58, 58 - 60), and (76 - 100, 100 - 106) horizons, from Table 23, have common properties of organic carbon, similar moisture holding characteristics, and do not have any confining layers. After combining similar horizons, a total of three below the plow layer are categorized. A total of four horizons for the total soil profile are designated and entered for NHORIZ.

[CARD 17.0: HORIZON NUMBER, HORIZON THICKNESS, BULK DENSITY, DISPERSION COEFFICIENT, PESTICIDE DECAY RATE, INITIAL SOIL WATER CONTENT, DRAINAGE PARAMETER(FORMAT I8, 6F8.0)]

CARD COLUMN

123456789012345678921234567893123456789412345678951234567896123456789712345
67898

1	15.0	1.68	0.0	0.0134	0.11	1
2	50.C	1.72	0.0	0.0134	0.13	1
3	50.0	1.60	0.0	0.0134	0.14	1
4	50.0	1.74	0.0	0.0134	0.16	1

CARD 17: Horizon thickness, initial soil water content

The thickness of the horizons (THKNS) are either divisions reported by the Soil Conservation Service or by the technique described for the number of horizons (CARD 16). The technique used from CARD 16 provides that the first horizon is 15 cm, the second is 25 cm, the third is 20 cm, and the fourth is 105 cm. The total thickness must not be greater than the total core depth of 165 cm as designated in CARD 15). The remaining parameters for this card, including 17A, are taken from Table 23.

The initial soil water content (THETO) is a reflection of the condition in which the field exists at the start of the simulation. Unless the condition is known, an initial condition of field capacity is assumed. These initial conditions will dampen out after a few days of run time.

[CARD 17.A: FIELD CAPACITY, WILTING POINT, SORPTION COEFFICIENT, ORGANIC CARBON CONTENT (FORMAT 8x, 4F8.0)]

0.11	0.010	0.80
0.13	0.050	0.40
0.14	0.090	0.20
0.16	0.110	0.10

NOTE: Organic carbon content not required for this data set.

[CARD 18.0: INITIAL LEVEL PESTICIDE INDICATOR AND CONVERSION FLAG FOR INITIAL RESIDUES (FORMAT 2I8)]

0 0

CARD 18: Initial level indicator

The initial level indicator (ILP) provides for initial conditions where existing levels of pesticide exist and these levels are entered in mg kg^{-1} or kg ha^{-1}. For the initial condition for the Dougherty Plain example, an assumption of non-existing background levels is made and a 0 is entered for ILP.

[CARD 19.0: HYDROLOGIC SUMMARY INDICATOR, TIME STEP OF OUTPUT, FREQUENCY OF SOIL COMPARTMENT REPORTING; PESTICIDE SUMMARY INDICATOR, TIME STEP OF OUTPUT, FREQUENCY OF SOIL COMPARTMENT REPORTING; PESTICIDE CONCENTRATION PROFILE INDICATOR, TIME STEP OF OUTPUT, FREQUENCY OF SOIL COMPARTMENT REPORTING (FORMAT 3(4x, A4, 4x, A4, I8)]

```
     WATR     YEAR        1
```

[CARD 20.0: NUMBER OF PLOTS (FORMAT I8)]

```
           1
```

[CARD 21.0: IDENTIFIER OF TIME SERIES, PLOTTING MODE, ARGUMENT OF VARIABLE, AND CONVERSION CONSTANT (FORMAT 4x, A4, 4x, A4, I8, F8.0)]

```
     RZFX     TCUM       10
```

6.5 GENERAL CALIBRATION AND EXPOSURE ASSESSMENT

Calibration, according to Donigian, A. S., Jr. et al., 1984. (Application of Hydrologic Program-FORTRAN (HSPF) in Iowa Agricultural Watersheds - EPA 600/S3-83-069), is an iterative procedure of parameter evaluation and refinement by which simulated and observed values of interest are compared. It is required for parameters that cannot be deterministically evaluated for a given site. Fortunately, the majority of PRZM parameters do not fall in this category. Calibration should be based on several years of simulation (3 to 5 is optimal) in order to evaluate parameters under a variety of climatic, soil moisture, and land use conditions. Calibration should be accomplished using years with normal to above normal precipitation. Calibration on years that are below normal may bias the parameter values because the parameters may not represent the processes occurring during wet periods. Calibration should result in parameter values that produce the best overall agreement between simulated and observed values throughout the calibration period (using parameter values within expected boundary ranges).

Calibration for runoff models includes the comparison of yearly and monthly runoff totals and individual storm events. The calibration should first be done with hydrology (runoff), followed by erosion (sediment) and then chemical (pesticide). A calibration scheme from Donigian, et al., is outlined below.

1. Estimate individual values for all parameters.

2. Perform hydrologic calibration run.

3. Compare simulated yearly and monthly values with observed data.

4. Adjust hydrologic parameter values (and initial conditions if necessary) to improve agreement between yearly and monthly values.

5. Repeat steps 2 and 3 until satisfactory agreement is reached.

6. Compare simulated and selected individual storm events.

7. Adjust hydrologic calibration parameters to improve agreement for individual storm events.

8. Repeat step 7 until satisfactory agreement is reached while maintaining agreement in the yearly and monthly runoff simulation.

9. The same procedure is followed for sediment and pesticide calibration. In the case of pesticide leaching, the observed data will also include soil profile concentrations.

At the conclusion of the above steps, PRZM is calibrated to the field being simulated under the land conditions in effect during the calibration period. The validation exercise on other years of observed data can be initiated or long term simulations for assessment can be accomplished.

Many times the user will not have the luxury of observed data to calibrate against and in some cases the assessment may warrant the collection of field data.

6.6 MODEL CALIBRATION WITH LIMITED DATA

The first task in assessing the correct hydrologic parameters for PRZM is to establish a water balance that is representative for the area simulated on an annual basis. The balance specifies the ultimate destination of incoming precipitation and is written as:

PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF - CHANGE IN STORAGE = DEEP PERCOLATION. (44)

In addition to the input meteorologic data series, the parameters that govern this balance are PFAC, ANETD, THEFC, THEWP, CN, and AMXDR. If a series of rainfall data and knowledge of the potential evapotranspiration or deep percolation exist, a representative water balance can be obtained by varying the above parameters.

The first parameter that should be adjusted is PFAC (pan factor). The value obtained from Figure 4 is relative and can be varied plus or minus 20%. The annual ET in our example is 60 to 80 cm per year and the annual runoff is 15.0 - 20.0 cm. The first step is to obtain several years of precipitation record that are average to above average for the area (1970, 1971, 1975, and 1976). The first calibration run produced 59.0, 65.0, 65.0, and 61.0 cm ET, which is low for the area. The pan factor should be increased because the simulated ET was low. Adjusting the value from 0.75 to 0.90 produces ET of 62.0, 70.0, 69.0, and 65.0 cm, which is higher than the first calibration run but still low for the area. The next parameter to adjust is ANETD (evaporation). Increasing the value from 25.0 cm to 30.0 cm produces 65.0, 72.0, 70.0, and 67.0 cm ET. The runoff is 26.0, 21.0, 18.0, and 17.0 cm year^{-1}. The water balance for ET and runoff appears representative.

Deep percolation results are 48.0, 49.0, 43.0, and 50.0 cm. Simulated calibration runs for [ET + RUNOFF + DLST + DEEP PERC = PRECIP (about 127 cm)] are representative of the region's hydrologic response. If it were not, an adjustment of the storage would be required with THEFC and THEWP varied. The difference between the two is the amount of water stored. To increase the storage, make more water available for ET, and allow less percolation, a larger difference is created. The length of time/runs for calibration is largely based on user experience. An experienced user would have a better estimate of hydrologic parameters (i.e., ANETD) and a shorter calibration exercise would be expected.

6.7 EXPOSURE ASSESSMENT, SENSITIVITY ANALYSIS, AND PRODUCTION RUNS

Many input parameters can be changed to affect the results of PRZM simulations. Sensitivity analyses should be made for those parameters that will have the greatest impact. Two categories of parameters--transport and supply--affect the amount of pesticide that leaches below a given depth. Transport parameters affect the movement of contaminants whereas supply parameters govern the quantity of the contaminant present for movement. The dominant transport and supply parameters for sensitivity testing with PRZM are provided in Table 25.

Table 25. PRZM Sensitivity Testing Parameters

Category	Parameter	
Transport	KD	(Adsorption Coefficient)
	BD	(Bulk Density)
	THEFC	(Field Capacity)
	THEWP	(Wilting Point)
	CN	(Curve Number)
Supply	RA	(Application Rate)
	KS	(Decay Rate)
	AL	(Active Layer--Root Zone)

The eight parameters provided in Table 25 will have an impact on the leaching of a chemical. In the majority of analyses, all of these values will not have to be varied. The application rate is usually fixed by specific label recommendations for any particular pesticide. The label rate would have to be varied only in an exercise where investigations of alternative management practices are indicated. Bulk density ranges from 1.0 - 2.0, with 1.4 - 1.6 g cm^{-3} commonly reported. In any case, its value has minimal effect on pesticide leaching. The curve numbers for a given soil series are generally fixed and usually do not require extensive variation. The decay rate, partition coefficient, soil moisture content, and depth of active layer (root zone) are very sensitive parameters that affect leaching. These parameters must be investigated to obtain a range of pesticide movement. Minimum, mean, and maximum values can be used in sensitivity testing. This same logic applies to many of the PRZM parameters. Figure 14 provides an example sensitivity testing scheme using the degradation rate constant, KS, as the parameter being varied.

		TEST 1.0				
HORIZON	FIELD CAPACITY	WILTING POINT	KD	KS	ROOT ZONE	MASS (g ha^{-1}) LEACHED PASSED ROOT ZONE
1	0.110	0.010	0.80	0.0268	45.0	11.0[a] 0.1[b] 40.0[c]
2	0.130	0.050	0.40	0.0268		
3	0.140	0.090	0.20	0.0268		
4	0.160	11.000	0.10	0.0268		
		TEST 2.0				
1	0.110	0.010	0.80	0.0134	45.0	60.0[a] 1.0[b] 228.0[c]
2	0.130	0.050	0.40	0.0134		
3	0.140	0.090	0.20	0.0134		
4.	0.160	11.000	0.10	0.0134		
		TEST 3.0				
1	0.110	0.010	0.80	0.0067	45.	114.0[a] 6.0[b] 340.0[c]
2	0.130	0.050	0.40	0.0067		
3	0.140	0.090	0.20	0.0067		
4	0.160	11.000	0.10	0.0067		

[a]mean value 28 years, [b]lowest year, [c]highest year

Figure 14. Example sensitivity testing scheme for KS.

Sensitivity testing provides a means to investigate the ranges of pesticide mass (g ha^{-1}) that will move below a certain depth.

An important issue in determining the leaching potential of a specific pesticide is its frequency or probability of leaching. Continuous simulation models that generate time series data provide a technique to evaluate exposure to various magnitudes and durations of chemical mass fluxes. Measures of exposure levels include the frequency (or percent of the time) specific conditions exist (for a chemical).

A period of record of at least 20 years may be required to derive a probability statement. The calibrated model and the available 28-year meteorologic record from the example can be used to derive probability statements about the events simulated.

The probability statement is estimated from the cumulative frequency distribution of the results. Several steps are required to complete the assessment after running the model.

STEP 1: Prepare a column of ranges of mass (g ha^{-1}) leaving the 45.0 cm root zone.

EXAMPLE:
0 - 20
20 - 40
40 - 60
60 - 80
80 - 100
100 - 120
120 - 140
140 - 300

STEP 2: Calculate the frequency with which results fall within each group from model results, the cumulative distribution, and cumulative frequency of the results.

YEAR	g ha^{-1} year^{-1} LEACHING PAST 45.0 cm ROOT ZONE		
		1964	228.0
1950	35.0	1965	28.0
1951	36.0	1966	27.0
1952	17.0	1967	16.0
1953	98.0	1968	16.0
1954	1.0	1969	70.0
1955	25.0	1970	87.0
1956	16.0	1971	83.0
1957	80.0	1972	31.0
1958	92.0	1973	29.0
1959	35.0	1974	49.0

1960	6.0	1975	49.0
1961	37.0	1976	109.0
1962	8.0	1977	34.0
1963	8.0		

RANGE	DISTRIBUTION	CUMULATIVE DISTRIBUTION	FREQUENCY DISTRIBUTION
0 - 20	8	8	0.29
20 - 40	10	18	0.64
40 - 60	2	20	0.71
60 - 80	2	22	0.79
80 - 100	4	26	0.93
100 - 120	1	27	0.96
120 - 300	1	28	1.00

STEP 3: Prepare a plot of grams leached below 45.0 cm versus cumulative frequency distribution - Figure 15.

The cumulative frequency distribution (CDF) enables a probability statement of leaching potential to be made and provides several important details of exposure information. The 50% value means that half the time less than 40 g ha^{-1} yr^{-1} will leach below the root zone. The return interval (RT) sometimes called recurrence or simple frequency is calculated using the equation:

$$RT = \frac{1}{1 - P(X \leq x)} \qquad (42)$$

where RT = return interval, years
$P(X \leq x)$ = probability of an event equal to or less than x occurring once in RT years

The return interval calculated from the 50% level is 2.0 years (or 40 g ha^{-1} will leach past the root zone every two years). For further demonstration suppose a risk level is set at the 80% level (or a return interval of 5 years). The annual mass leaching beyond the root zone with a 5 year RT is 80.0 g ha^{-1}.

Continuous simulation modeling can also be used to evaluate different management practices and their effect on the leaching potential. Consider for example a change in the timing of pesticide application. The increase or decrease in risk expected from altering the timing of the application can be investigated using the procedure just outlined. The pesticide

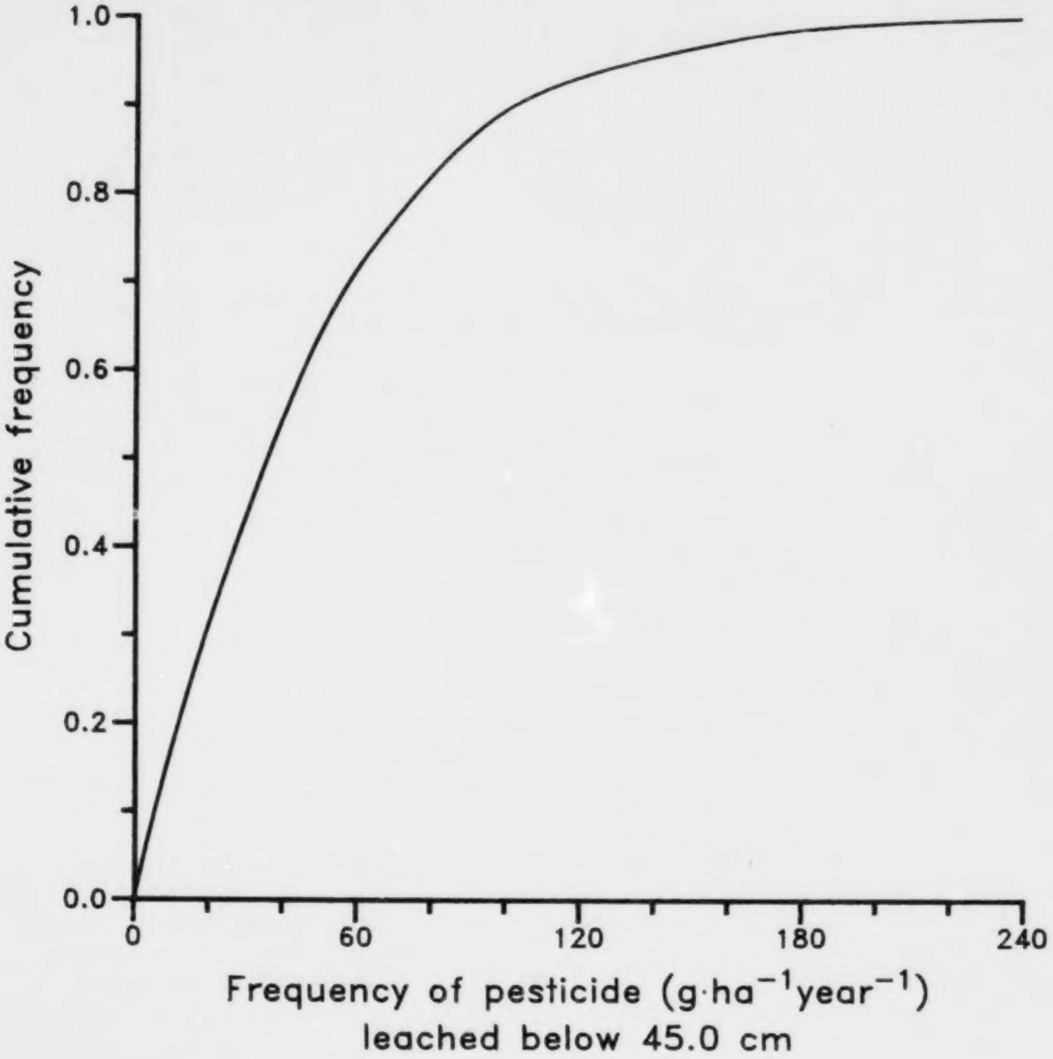

Figure 15. Cumulative frequency distribution of pesticide leaving root zone.

application will be delayed approximately 30 days. The results are presented below.

YEAR	$g\ ha^{-1}\ year^{-1}$ LEACHING PAST 45.0-cm ROOT ZONE		
1950	26.0	1965	26.0
1951	39.0	1966	35.0
1952	19.0	1967	22.0
1953	113.0	1968	18.0
1954	1.0	1969	83.0
1955	21.0	1970	101.0
1956	17.0	1971	76.0
1957	90.0	1972	45.0
1958	66.0	1973	19.0
1959	49.0	1974	56.0
1960	18.0	1975	19.0
1961	39.0	1976	119.0
1962	29.0	1977	43.0
1963	90.0		
1964	149.0		

RANGE	DISTRIBUTION	CUMULATIVE DISTRIBUTION	FREQUENCY DISTRIBUTION
0 - 20	8	8	0.29
20 - 40	7	15	0.54
40 - 60	4	19	0.68
60 - 80	2	21	0.75
80 - 100	3	24	0.86
100 - 120	3	27	0.96
120 - 150	1	28	1.00

For our example, the amount of pesticide leaving the root zone at the 80% (or return interval of 5 years) is 80.0 g ha^{-1}. The risk apparently has not been decreased because the frequency curves for the 80% values are the same. This finding does not produce results that would be expected (reduced risk), because delaying the application should result in more removal (i.e uptake, etc.). Analysis of the data, however, indicates that uptake is increased only 1% by delaying the application. This example did not include a potential faster rate of decay due to higher soil temperatures (by delaying the application). The example does demonstrate the utility of continuous simulation modeling in assessing management alternatives.

6.8 DOCUMENTATION AND REPORTING OF RESULTS

The degree, or extent, of pesticide interaction within a hydrologic response depends on a variety of critical compound and site characteristics. These critical characteristics are essential to understanding/determining the leaching potential of a pesticide. The ultimate goal of such understanding is to perform consistent assessments under a variety of circumstances. A reliable investigation of pesticide movement through the unsaturated zone requires the assessment of soils, hydrologic site characteristics, climatic information, agronomic practices, and pesticide properties/interactions. Many times such information will have to be either estimated or obtained through a variety of sources. A thorough documentation of the information used/estimated is required for a successful application of PRZM. Documentation provides a record of data sources, promotes ease of operation for other users, decreases operational learning curve requirement (increases user efficiency), and serves as a quick reference for future use. Figure 16 provides an example of an assessment data sheet for PRZM simulations.

Site: Date of Assessment:
Site Characteristics:
Investigator:
Compound Name:

Note: Can be used separately or attached to hard copy output.

Compound Characteristics:
Critical Hydrology Parameters:

- hydrologic group
- depth of horizons
- depth of root zone
- depth of unsaturated zone
- evapotranspiration extraction
- number of horizons
- field capacity, wilting point, saturation, and drainage alpha
- meteorologic station
- crop and cropping information

Critical Pesticide Parameters:

- sorption constant
- decay rate
- bulk density
- depth of incorporation
- application rate
- application date

Sources of Information:

Calculation of Options Used for Parameter Estimation:

Exposure Assessment Methodology:

Figure 16. Documentation data sheet for a PRZM assessment of the unsaturated zone.

APPENDIX A:

PRZM DEVELOPMENTAL REFERENCES

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APPENDIX B:
SOIL NAMES AND HYDROLOGIC CLASSIFICATIONS

AABERG	C	AHL	C	ALMY	B	ANLAUF	C	AROOSTOOK	
AASTAD	B	AHLSTROM	C	ALOHA	C	ANNABELLA	B	ARDSA	C
ABAC	D	AHMEEK	B	ALONSD	B	ANNANDALE	C	ARP	C
ABAJO	C	AHOLT	D	ALOVAR	C	ANNISTON	C	ARRINGTON	B
ABBOTT	D	ANTANUM	C	ALPENA	B	ANGXA	A	ARRITOLA	D
ABBOTTSTOWN	C	AHWAHNEE	C	ALPHA	C	ANONES	C	ARROLIME	C
ABCAL	D	AIBONITO	C	ALPUN	B	ANSARI	D	ARRON	D
ABEGG	B	AIKEN	B/C	ALPOWA	B	ANSEL	B	ARROW	B
ABELA	B	AIKMAN	D	ALPS	C	ANSELMO	A	ARROWSMITH	B
ABELL	B	AILEY	B	ALSEA	B	ANSON	B	ARROYO SECO	B
ABERDEEN	D	AINAKEA	B	ALSPAUGH	C	ANTELOPE SP	C	ARTA	C
ABES	D	AIRMONT	C	ALSTAD	B	ANTERO	C	ARTOIS	C
ABILENE	C	AIROTSA	B	ALSTOWN	B	ANT FLAT	C	ARVADA	D
ABINGTON	B	AIRPORT	D	ALTAMONT	D	ANTHO	B	ARVANA	C
ABIQUA	C	AITS	B	ALTAVISTA	C	ANTHONY	B	ARVESON	D
ABO	B/C	AJO	C	ALTDORF	D	ANTIGO	B	ARVILLA	B
ABOR	D	AKAKA	A	ALTMAR	B	ANTILON	B	ARZELL	C
ABRA	C	AKASKA	B	ALTO	C	ANTIOCH	D	ASA	B
ABRAHAM	B	AKELA	C	ALTOGA	C	ANTLER	C	ASBURY	B
ABSAROKEE	C	ALADDIN	B	ALTON	B	ANTOINE	C	ASCALON	B
ABSCOTA	B	ALAE	A	ALTUS	B	ANTROBUS	B	ASCHOFF	B
ABSHER	D	ALAELOA	B	ALTVAN	B	ANTY	B	ASHBY	C
ABSTED	D	ALAGA	A	ALUM	B	ANVIK	B	ASHCROFT	B
ACACIO	C	ALAKAI	D	ALUSA	D	ANWAY	B	ASHDALE	B
ACADEMY	C	ALAMA	B	ALVIN	B	ANZA	B	ASHE	B
ACADIA	D	ALAMANCE	B	ALVIRA	C	ANZIANO	C	ASHKUM	C
ACANA	D	ALAMO	D	ALVISO	D	APACHE	D	ASHLAR	B
ACASCO	D	ALAMOSA	C	ALVOR	C	APAXUIE	A	ASHLEY	A
ACEITUNAS	B	ALAPAHA	D	AMADOR	D	APISHAPA	C	ASH SPRINGS	C
ACEL	D	ALAPAI	A	AMAGON	D	APISON	B	ASHTON	B
ACKER	B	ALBAN	B	AMALU	D	APOPKA	A	ASHUE	B
ACKMEN	B	ALBANO	D	AMANA	B	APPIAN	C	ASHUELOT	C
ACME	C	ALBANY	C	AMARGOSA	D	APPLEGATE	C	ASHWOOD	C
ACO	B	ALBATON	D	AMARILLO	B	APPLETON	C	ASKEW	C

ACOLITA	B	ALBEE	C	AMASA	B	APPLING	B	ASO	C
ACOMA	C	ALBEMARLE	B	AMBERSON		APRON	B	ASOTIN	C
ACOVE	C	ALBERTVILLE	C	AMBOY	C	APT	C	ASPEN	B
ACREE	C	ALBIA	C	AMBRAW	C	APTAKISIC	B	ASPERMONT	B
ACRELANE	C	ALBION	B	AMEDEE	A	ARABY		ASSINNIBOINE	B
ACTON	B	ALBRIGHTS	C	AMELIA	B	ARADA	C	ASSUMPTION	B
ACUFF	B	ALCALDE	C	AMENIA	B	ARANSAS	D	ASTATULA	A
ASWORTH	B	ALCESTER	B	AMERICUS	A	ARAPIEN	C	ASTOR	A/D
ACY	C	ALCOA	B	AMES	C	ARAVE	O	ASTORIA	B
ADA	B	ALCONA	B	AMESHA	B	ARAVETON	B	ATASCADERO	C
ADAIR	D	ALCOVA	B	AMHERST	C	ARBELA	O	ATASCOSA	D
ADAMS	A	ALDA	C	AMITY	C	ARBONE	B	ATCO	B
ADAMSON	B	ALDAX	D	AMMON	B	ARBOR	B	ATENCIO	B
ADAMSTOWN		ALDEN	D	AMOLE	C	ARBUCKLE	B	ATEPIC	D
ADAMSVILLE	C	ALDER	B	AMOR	B	ARCATA	B	ATHELWOLD	B
ADATON	D	ALDERDALE	C	AMOS	C	ARCH	B	ATHENA	B
ADAVEN	D	ALDERWOOD	C	AMSDEN	B	ARCHABAL	B	ATHENS	B
ADDIELOU	C	ALDINO	C	AMSTERDAM	B	ARCHER	C	ATHERLY	B
ADDISON	D	ALDWELL	C	AMTOFT	D	ARCHIN	C	ATHERTON	B/D
ADDY	C	ALEKNAGIK	B	AMY	D	ARCO	B	ATHMAR	C
ADE	A	ALEMEDA	C	ANACAPA	B	ARCOLA	C	ATHOL	B
ADEL	A	ALEX	B	ANAHUAC	D	ARD	C	ATKINSON	B
ADELAIDE	D	ALEXANDRIA	C	ANAMITE	D	ARDEN	B	ATLAS	D
ADELANTO	B	ALEXIS	B	ANAPRA	B	ARDENVOIR	B	ATLEE	C
ADELINO	B	ALFORD	B	ANASAZI	B	ARDILLA	C	ATMORE	B/D
ADELPHIA	C	ALGANSEE	B	ANATONE	D	AREDALE	B	ATOKA	C
ADENA	C	ALGERITA	B	ANAVERDE	B	ARENA	C	ATON	B
ADGER	D	ALGIERS	C/D	ANAWALT	D	ARENALES		ATRYPA	C
ADILIS	A	ALGOMA	B/D	ANCHO	B	ARENDTSVILLE	B	ATSION	C
ADIRONDACK		ALHAMBRA	B	ANCHORAGE	A	ARENOSA	A	ATTERBERRY	B
ADIV	B	ALICE	A	ANCHOR BAY	D	ARENZVILLE	B	ATTEWAN	A
ADJUNTAS	C	ALICEL	BV	ANCHOR POINT	D	ARGONAUT	D	ATTICA	B
ADKINS	B	ALICIA	B	ANOLOTE	D	ARGUELLO	B	ATTLEBORO	
ADLER	C	ALIDA	B	ANCO	C	ARGYLE	B	ATWATER	B
ADOLPH	D	ALIKCHI	B	ANDERLY	C	ARIEL	C	ATWELL	C/D
ADRIAN	A/D	ALINE	A	ANDERS	C	ARIZO	A	ATWOOD	B
AENEAS	B	ALKO	D	ADERSON	B	ARKABUTLA	C	AUBBEENAUBBEE	B
AETNA	B	ALLAGASH	B	ANDES	C	ARKPORT	B	AUBERRY	B

AFTON	D	ALLARD	B	ANDORINIA	C	ARLAND	B	AUBURN	C/D
AGAR	B	ALLEGHENY	B	ANDOVER	D	ARLE	B	AUBURNDALE	D
AGASSIZ	D	ALLEMANDS	D	ANDREEN	B	ARLING	D	AUDIAN	B
AGATE	D	ALLEN	B	ANDREESON	C	ARLINGTON	C	AU GRES	C
AGAWAM	B	ALLENDALE	C	ANDRES	B	ARLOVAL	C	AUGSBURG	B
AGENCY	C	ALLENS PARK	B	ANDRES	C	ARMAGH	D	AUGUSTA	C
AGER	D	ALLENSVILLE	C	ANED	D	ARMIJO	D	AULD	D
AGNER	B	ALLENTINE	D	ANETH	A	ARMINGTON	D	AURA	B
AGNEW	B/C	ALLENWOOD	B	ANGELICA	D	ARMO	B	AURORA	C
AGNOS	B	ALLESSIO	B	ANGELINA	B/D	ARMOUR	B	AUSTIN	C
AGUA	B	ALLEY	C	ANGELO	C	ARMSTER	C	AUSTWELL	D
AGUADILLA	A	ALLIANCE	B	ANGIE	C	ARMSTRONG	D	AUXVASSE	D
AGUA DULCE	C	ALLIGATOR	D	ANGLE	A	ARMJOHEE	D	AUZQUI	B
AGUA FRIA	B	ALLIS	D	ANGLEN	B	ARNEGARD	B	AVA	C
AGUALT	B	ALLISON	C	ANGOLA	C	ARNHART	C	AVALANCHE	B
AGUEDA	B	ALLOUEZ	C	ANGOSTORA	B	ARNHEIM	C	AVALON	B
AGUILITA	B	ALLOWAY		ANHALT	D	ARNO	D	AVERY	B
AGUIRRE	D	ALMAC	B	ANIAK	D	ARNOLD	B	AVON	C
AGUSTIN	B	ALMENA	C	ANITA	D	ARNOT	C/D	AVONBURG	D
AHATONE	D	ALMONT	D	ANKENY	A	ARNY	A	AVONDALE	E
AWBREY	D	BARKER	C	BECKET	C	BERRENDOS	D	BLACKROCK	B
AXTELL	D	BARKERVILLE	C	BECKLEY	B	BERRYLAND	D	BLACKSTON	B
AYAR	D	BARKLEY	B	BECKTON	D	BERTELSON	B	BLACKTAIL	B
AYCOCK	B	BARLANE	D	BECKWITH	C	BERTHOUD	B	BLACKWATER	D
AYON	B	BARLING	C	BECKWOURTH	B	BERTIE	C	BLACKWELL	B/D
AYR	B	BARLOW	B	BECREEK	B	BERTOLOTTI	B	BLADEN	D
AYRES	D	BARNARD	D	BEDFORD	C	BERTRAND	B	BLAGO	D
AYRSHIRE	C	BARNES	B	BEDINGTON	B	BERVILLE	D	BLAINE	B
AYSEES	B	BARNESTON	B	BEDNER	C	BERYL	B	BLAIR	C
AZAAR	C	BARNEY	A	BEEBE	A	BESSEMER	B	BLAIRTON	C
AZARMAN	C	BARNHARDT	B	BEECHER	C	BETHANY	C	BLAKE	C
AZELTINE	B	BARNSTEAD		BEECHY		BETHEL	D	BLAKELAND	A
AZFIELD	B	BARNUM	B	BEEHIVE	B	BETTERAVIA	C	BLAKENEY	C
AZTALAN	B	BARRADA	D	BEEK	C	BETTS	B	BLAKEPORT	B
AZTEC	B	BARRETT	D	BEENOM	D	BEULAH	B	BLALOCK	D
AZULE	C	BARRINGTON	B	BEEZAR	B	BEVENT	B	BLAMER	C
AZWELL	B	BARRON	B	BEGAY	B	BEVERLY	B	BLANCA	B
		BARRONETT	C	BEGOSHIAN	C	BEW	D	BLANCHARD	A

BABB	A
BABBINGTON	B
BABCOCK	C
BABYLON	A
BACA	C
BACH	D
BACHUS	C
BACKBONE	A
BACULAN	A
BADENAUGH	B
BADGER	C
BADGERTON	B
BADO	D
BADUS	C
BAGARD	C
BAGDAD	B
BAGGOTT	D
BAGLEY	B
BAHEM	B
BAILE	D
BAINVILLE	C
BAIRD HOLLOW	C
BAJURA	D
BAKEOVEN	D
BAKER	D
BAKER PASS	D
BALAAM	A
BALCH	D
BALCOM	B
BALD	C
BALDER	C
BALDOCK	B/C
BALDWIN	D
BALDY	B
BALE	C
BALLARD	B
BALLER	D
BALLINGER	C
BARROWS	D
BARRY	D
BARSTOW	B
BARTH	C
BARTINE	C
BARTLE	D
BARTLEY	C
BARTON	B
BARTONFLAT	B
BARVON	C
BASCOM	B
BASEHOR	D
BASHAW	D
BASHER	B
BASILE	D
BASIN	C
BASINGER	C
BASKET	C
BASS	A
BASSEL	B
BASSETT	B
BASSFIELD	B
BASSLER	D
BASTIAN	D
BASTROP	B
BATA	A
BATAVIA	B
BATES	B
BATH	C
BATTERSON	D
BATTLE CREEK	C
BATZA	D
BAUDETTE	B
BAUER	C
BAUGH	B/C
BAXTER	B
BAXTERVILLE	B
BAYAMON	B
BEHANIN	B
BEHEMOTOSH	B
BEHRING	D
BEIRMAN	D
BEJUCOS	B
BELCHER	D
BELDEN	D
BELDING	B
BELEN	C
BELFAST	B
BELFIELD	B
BELFORE	B
BELGRADE	B
BELINDA	D
BELKNAP	C
BELLAMY	C
BELLAVISTA	D
BELLE	B
BELLEFONTAINE	
BELLICUM	B
BELLINGHAM	C
BELLPINE	C
BELMONT	B
BELMORE	B
BELT	D
BELTED	D
BELTON	C
BELTRAMI	B
BELTSVILLE	C
BELUGA	D
BELVOIR	C
BENCLARE	C
BENEVOLA	C
BENEWAH	C
BENFIRLD	C
BENGE	B
BEN HUR	B
BENIN	D
BEWLEYVILLE	B
BEWLIN	D
BEXAR	C
BEZZANT	B
BIBB	B/D
BIBON	A
BICKELTON	B
BICKLETON	C
BICKMORE	C
BICONDOA	C
BIDDEFORD	D
BIDDLEMAN	C
BIDMAN	C
BIDWELL	B
BIEBER	D
BIENVILLE	A
BIG BLUE	D
BIGEL	A
BIGELOW	C
BIGETTY	C
BIGGS	A
BIGGSVILLE	B
BIG HORN	C
BIGNELL	B
BIG TIMBER	D
BIGWIN	D
BIJOU	A
BILLETT	A
BILLINGS	C
BINDLE	B
BINFORD	B
BINGHAM	B
BINNSVILLE	D
BINS	B
BINTON	C
BIPPUS	B
BIRCH	A
BIRCHWOOD	C
BLANCHESTER	B/D
BLAND	C
BLANDFORD	C
BLANDING	B
BLANEY	B
BLANKET	C
BLANTON	A
BLANYON	C
BLASDELL	A
BLASINGAME	C
BLAZON	D
BLENCOE	C
BLEND	D
BLENDON	B
BLETHEN	E
BLEVINS	B
BLEVINTON	B/D
BLIOHTON	D
BLISS	D
BLOCKTON	C
BLODGETT	A
BLOMFORD	B
BLOOM	C
BLOOMFIELD	A
BLOOMING	B
BLOOK	D
BLOSSOM	C
BLOUNT	C
BLOUNTVILLE	C
BLUCHER	C
BLUEBELL	C
BLUE EARTH	D
BLUEJOINT	B
BLUE LAKE	A
BLUEPOINT	B
BLUE STAR	B
BLUEWING	B
BLUFFDALE	C

BALM	B/C	BAYARD	A	BENITO	D	BIRDOW	B	BLUFFTON	D
BALMAN	B/C	BAYBORO	D	BENJAMIN	D	BIRDS	C	BLUFORD	D
BALON	B	BAYERTON	C	BEN LOMOND	B	BIRDSALL	D	BLY	B
BALTIC	D	BAYLOR	D	BENMAN	A	BIRDSBORO	B	BLYTHE	D
BALTIMORE	B	BAYSHORE	B/C	BENNDALE	B	BIRDSLEY	D	BOARDTREE	C
BALTO	D	BAYSIDE	C	BENNETT	C	BIRKBECK	B	BOBS	D
BAMBER	B	BVAYUCOS	D	BENNINGTON	D	BISBEE	A	BOBTAIL	B
BAMFORTH	B	BAYWOOD	A	BENOIT	D	BISCAY	C	BOCK	B
BANCAS	B	BAZETTE	C	BENSON	C/D	BISHOP	B/C	BODELL	D
BANCROFT	B	BAZILE	B	BETNTEEN	B	BISPING	B	BODENBURG	B
BANDERA	B	BEAD	C	BENTONVILLE	C	BISSELL	B	BODINE	B
BANGO	C	BEADLE	C	BENZ	D	BISTI	C	BOEL	A
BANGOR	B	BEALES	A	BEOTIA	B	BIT	D	BOELUS	A
BANGSTON	A	BEAR BASIN	B	BEOWAWE	D	BITTERON	A	BOESEL	B
BANKARD	A	BEAR CREEK	C	BERCAIL	C	BITTERROOT	C	BOETTCHER	C
BANKS	A	BEARDALL	C	BERDA	B	BITTER SPRING	C	BOGAN	C
BANNER	C	BEARDEN	C	BEREA	C	BITTON	B	BOGART	B
BANNERVILLE	C/D	BEARDSTOWN	C	BERENICETON	B	BIXBY	B	BOGUE	D
BANNOCK	B	BEAR LAKE	D	BERENT	A	BJORK	C	BOHANNON	C
BANQUETE	D	BEARMOUTH	A	BERGLAND	D	BLANCHLY	C	BOHEMIAN	B
BARABOO	B	BEARPAW	B	BERGSTROM	B	BLACKBURN	B	BOISTFORT	C
BARAGA	C	BEAR PRAIRIE	B	BERINO	B	BLACK BUTTE	C	BOLAR	C
BARBARY	D	BEARSKIN	D	BERKELEY		BLACK CANYON	D	BOLD	B
BARBOUR	B	BEASLEY	C	BERKS	C	BLACKCAP	A	BOLES	C
BARBOURVILLE	B	BEASON	C	BERKSHIRE	B	BLACKETT	B	BOLIVAR	B
BARCLAY	C	BEATON	C	BERLIN	C	BLACKFOOT	B/C	BOLIVIA	B
BARCO	B	BEATTY	C	BERMESA	C	BLACKHALL	D	BOLTON	B
BARCUS	B	BEAUCOUP	B	BERMUDIAN	B	BLACKHAWK	D	BOMDAY	B
BARD	D	BEAUFORD	D	BERNAL	D	BLACKLEAF	B	BON	B
BARDEN	C	BEAUMONT	D	BERNALDO	B	BLACKLEED	A	BONACCORD	D
BARDLEY	C	BEAUREGARD	C	BERNARD	D	BLACKLUCK	D	BONAPARTE	A
BARELA	C	BEAUSITE	B	BERNARDINO	C	BLACKMAN	C	BOND	D
BARFIELD	D	BEAUVAIS	B	BERNARDSTON	C	BLACK MOUNTAIN	D	BONDRANCH	D
BARFUSS	B	BEAVERTON	A	BERNHILL	B	BLACKOAR	C	BONDURANT	B
BARGE	C	BECK	C	BERNICE	A	BLACKPIPE	C	BONE	D
BARISHMAN	C	BECKER	B	BERNING	C	BLACK RIDGE	D	BONG	B
BONHAM	C	BRANDON	B	BROOKLYN	D	BUSTER	C	CAMPSPASS	C
BONIFAY	A	BRANDYWINE	C	BROOKSIDE	C	BURANO	C	CAMPUS	B

BONILLA	B	BRANFORD	B	BROOKSTON	B/D	BUTLER	D	CAMRODEN	C
BONITA	D	BRANTFORD	B	BROOKSVILLE	D	BUTLERTOWN	C	CANA	C
BONN	D	BRANYON	D	BROOMFIELD	D	BUTTE	C	CANAAN	C/D
BONNER	B	BRASHEAR	C	BROSELEY	B	BUTTERFIELD	C	CANADIAN	B
BONNET	B	BRASSFIELD	B	BROSS	B	BUTTON	C	CANADICE	D
BONNEVILLE	B	BRATTON	B	BROUGHTON	D	BUXIN	D	CANANDAIGUA	D
BONNICK	A	BRAVANE	D	BROWARD	C	BUXTON	C	CANASERAGA	C
BONNIE	D	BRAXTON	C	BROWNELL	B	BYARS	D	CANAVERAL	C
BONO	D	BRAYMILL	B/D	BROWNFIELD	A	BYNUM	C	CANBURN	D
BONSALL	D	BRAYS	D	BROWNLEE	B	BYRON	A	CANDELERO	C
BONTA	C	BRAYTON	C	BROYLES	B			CANE	C
BONTI	C	BRAZITO	A	BRUCE	D	CABALLO	B	CANEADEA	D
BOOKER	D	BRAZOS	A	BRUFFY	C	CABARTON	D	CANEEK	B
BOOMER	B	BREA	B	BRUIN	C	CABBA	C	CANEL	B
BOONE	A	BRECKENRIDGE	D	BRUNEEL	B/C	CABBART	D	CANELO	D
BOONESBORO	B	BRECKNOCK	B	BRUNO	A	CABEZON	D	CANEY	C
BOONTON	C	BREECE	B	BRUNT	C	CABIN	C	CANEYVILLE	C
BOOTH	C	BREGAR	D	BRUSH		CABINET	C	CANEZ	B
BORACHO	C	BREMEN	B	BRUSSETT	B	CABLE	D	CANFIELD	C
BORAH	A/C	BREMER	B	BRYAN	A	CABO ROJO	C	CANISTED	C
BORDA	D	BREMO	C	BRYCAN	B	CABOT	D	CANNINGER	D
BORDEAUX	B	BREMS	A	BRYCE	D	CACAPON	B	CANNON	B
BORDEN	B	BRENDA	C	BUCAN	D	CACHE	D	CANOE	B
BORDER	B	BRENNAN	B	BUCHANAN	C	CACIQUE	C	CANONCITO	B
BORNSTEDT	C	BRENNER	C/D	BUCHENAU	C	CADDO	D	CANOVA	B/D
BORREGO	C	BRENT	C	BUCHER	C	CADEVILLE	D	CANTALA	B
BORUP	B	BRENTON	B	BUCKHOUSE	A	CADMUS	B	CANTON	B
BORVANT	D	BRENTWOOD	B	BUCKINGHAM		CADOMA	D	CANTRIL	B
BORZA	C	BRESSER	B	BUCKLAND	C	CADOR	C	CANTUA	B
BOSANKO	D	BREVARD	B	BUCKLEBAR	B	CAGEY	C	CANUTIO	B
BOSCO	B	BREVORT	B	BUCKLEY	B/C	CAGUABO	D	CANYON	D
BOSKET	B	BREWER	C	BUCKLON	D	CAGWIN	B	CAPAC	B
BOSLER	B	BREWSTER	D	BUCKNER	A	CAHABA	B	CAPAY	D
BOSQUE	B	BREWTON	C	BUCKNEY	A	CAHILL	B	CAPE	D
BOSS	D	BRICKEL	C	BUCKS	B	CAHONE	C	CAPE FEAR	D
BOSTON	C	BRICKTON	C	BUCKSKIN	C	CAHTO	C	CAPERS	D
BOSTWICK	B	BRIDGE	C	BUCODA	C	CAID	B	CAPILLO	C
BOSWELL	D	BRIDGEHAMPTON	B	BUDD	B	CAIRO	D	CAPLES	C

BOSWORTH	D	BRIDGEPORT	B	BUDE	C	CAJALCO	C	CAPPS	B
BOTELLA	B	BRIDGER	A	BUELL	B	CAJON	A	CAPSHAW	C
BOTHWELL	C	BRIDGESON	B/C	BUENA VISTA	B	CALABAR	D	CAPULIN	B
BOTTINEAU	C	BRIDGET	B	BUFFINGTON	B	CALABASAS	B	CAPUTA	C
BOTTLE	A	BRIDGEVILLE	B	BUFFMEYER	B	CALAIS	C	CARACO	C
BOULDER	B	BRIDGPORT	B	BUFF PEAK	C	CALAMINE	D	CARALAMPI	B
BOULDER LAKE	D	BRIEDWELL	B	BUICK	C	CALAPOOYA	C	CARBO	C
BOULDER POINT	B	BRIEF	B	BUIST	B	CALAWAH	B	CARBOL	D
BOULFLAT	D	BRIENSBURG		BUKREEK	B	CALCO	C	CARBONDALE	D
BOURNE	C	BRIGGS	A	BULLION	D	CALDER	D	CARBURY	B
BOW	C	BRIGGSDALE	C	BULLREY	B	CALDWELL	B	CARCITY	D
BOWBAC	C	BRIGGSVILLE	C	BULL RUN	B	CALEAST	C	CARDIFF	B
BOWBELLS	B	BRIGHTON	A/D	BULL TRAIL	B	CALEB	B	CARDINGTON	C
BOWDOIN	D	BRIGHTWOOD	C	BULLY	B	CALERA	C	CARDON	D
BOWDRE	C	BRILL	B	BUMGARD	B	CALHI	A	CAREY	B
BOWERS	C	BRIM	C	BUNCOMBE	A	CALHOUN	D	CAREY LAKE	B
BOWIE	B	BRIMFIELD	C/D	BUNDO	B	CALICO	D	CAREYTOWN	D
BOWMAN	B/D	BRIMLEY	B	BUNDYMAN	C	CALIFON	C	CARGILL	C
BOWMANSVILLE	C	BRINEGAR	B	BUNEJUG	C	CALIMUS	BV	CARIBE	B
BOXELDER	C	BRINKERT	C	BUNDER	D	CALITA	B	CARIBEL	B
BOXWELL	C	BRINKERTON	D	BUNSELMEIER	C	CALIZA	B	CARIBOU	B
BOY	A	BRISCOT	B	BUNTINGVILLE	B/C	CALKINS	C	CARLIN	D
BOYCE	B/D	BRITE	C	BUNYAN	B	CALLABO	C	CARLINTON	B
BOYD	D	BRITTON	C	BURBANK	A	CALLAHAN	C	CARLISLE	A/D
BOYER	B	BRIZAM	A	BURCH	B	CALLEGUAS	D	CARLOTTA	B
BOYNTON		BROAD	C	BURCHARD	B	CALLINGS	C	CARLOW	D
BOYSAG	D	BROADALBIN	C	BURCHELL	B/C	CALLOWAY	C	CARLSBAD	C
BOYSEN	D	BROADAX	B	BURDETT	C	CALMAR	B	CARLSBORG	A
BOZARTH	C	BROADBROOK	C	BUREN	C	CALNEVA	C	CARLSON	C
BOZE	B	BROAD CANYON	B	BURGESS	C	CALOUSE	B	CARLTON	B
BOZEMAN	A	BROADHEAD	C	BURGI	B	CALPINE	B	CARMI	B
BRACEVILLE	C	BROADHURST	D	BURGIN	D	CALVERT	D	CARNASAW	C
BRACKEN	D	BROCK	D	BURKE	C	CALVERTON	C	CARNEGIE	C
BRACKETT	C	BROCKLISS	C	BURKHARDT	B	CALVIN	C	CARNERO	C
BRAD	D	BROCKMAN	C	BURLEIGH	D	CALVISTA	D	CARNEY	D
BRADDOCK	C	BROCKO	B	BURLESON	D	CAM	B	CAROLINE	C
BRADENTON	B/D	BROCKPORT	D	BURLINGTON	A	CAMAGUEY	D	CARR	B
BRADER	D	BROCKTON	D	BURMA		CAMARCO	B	CARRISALITOS	D

BRADFORD	B	BROCKWAY	B	BURMESTER	D	CAMARILLO	B/C	CARRIZO	A
BRADSHAW	B	BRODY	C	BURNAC	C	CAMAS	A	CARSITAS	A
BRADWAY	D	BROE	B	BURNETTE	B	CAMAS CREEK	B/D	CARSLEY	C
BRADY	B	BROGAN	B	BURNHAM	D	CAMBERN	C	CARSO	D
BRADYVILLE	C	BROGDON	B	BURNSIDE	B	CAMBRIDGE	C	CARSON	D
BRAHAM	B	BROLLIAR	D	BURNSVILLE	B	CAMDEN	B	CARSTAIRS	B
BRAINERD	B	BROMO	B	BURNT LAKE	B	CAMERON	D	CARSTUMP	C
BRALLIER	D	BRONAUGH	B	BURRIS	D	CAMILLUS	B	CART	B
BRAM	B	BRONCHO	B	BURT	D	CAMP	B	CARTAGENA	D
BRAMARD	B	BRONSON	B	BURTON	B	CAMPBELL	B/C	CARTEOAY	C
BRAMBLE	C	BRONTE	C	BUSE	B	CAMPHORA	B	CARUSO	C
BRAMWELL	C	BROOKE	C	BUSH	B	CAMPIA	B	CARUTHERSVILLE	B
BRAND	D	BROOKFIELD	B	BUSHNELL	C	CAMPO	C	CARVER	A
BRANDENBURG	A	BROOKINGS	B	BUSHVALLEY	D	CAMPONE	B/C	CARWILE	D
CARYVILLE	B	CENTRAL POINT	B	CHILGREN	C	CLARESON	C	COKEDALE	B/C
CASA GRANDE	C	CERESCO	A	CHILHOWIE	C	CLAREVILLE	C	COKEL	B
CASCADE	C	CERRILLOS	B	CHILI	B	CLARINDA	D	COKER	D
CASCAJO	B	CERRO	C	CHILKAT	C	CLARION	B	COKESBURY	D
CASCILLA	B	CHACRA	C	CHILLICOTHE	C	CLARITA	D	COKEVILLE	B
CASCO	B	CHAFFEE	C	CHILLISQUAQUE		CLARK	B	COLBATH	C/D
CASE	B	CHAGRIN	B	CHILLUM	B	CLARK FORK	A	COLBERT	D
CASEBIER	D	CHAIX	B	CHILMARK	B	CLARKSBURG	C	COLBURN	B
CASEY	C	CHALFONT	C	CHILO	B/D	CLARKSDALE	C	COLBY	B
CASHEL	C	CHALMERS	C	CHILOQUIN	B	CLARKSON	B	COLCHESTER	B
CASHION	D	CHAMA	B	CHILSON	D	CLARKSVILLE	B	COLDCREEK	B
CASHMERE	B	CHAMBER	C	CHILTON	B	CLARNO	B	COLDEN	D
CASHMONT	B	CHAMBERINO	C	CHIMAYO	D	CLARY	B	COLD SPRINGS	C
CASINO	A	CHAMISE	B	CHIMNEY	B	CLATO	B	COLE	B/C
CASITO	D	CHAMOKANE	B	CHINA CREEK	B	CLATSOP	D	COLEBROOK	B
CASPAR	B	CHAMPION	B	CHINCHALLO	B/D	CLAVERACK	C	COLEMAN	C
CASPIANA	B	CHANCE	B/D	CHINIAK	A	CLAWSON	C	COLEMANTOWN	D
CASS	A	CHANDLER	B	CHINO	B/C	CLAYBURN	B	COLETO	A
CASSADAGA		CHANEY	C	CHINOOK	B	CLAYSPRINGS	D	COLFAX	C
CASSIA	C	CHANNAHON	B	CHIPETA	D	CLAYTON	B	COLIBRO	B
CASSIRO	C	CHANNING	B	CHIPLEY	C	CLEARFIELD	C	COLINAS	B
CASSOLARY	B	CHANTA	B	CHIPMAN	D	CLEAR LAKE	D	COLLAMER	C
CASSVILLE		CHANTIER	D	CHIPPENY	D	CLEEK	C	COLLARD	B
CASTAIC	C	CHAPIN	C	CHIPPEWA	B/D	CLE ELUM	B	COLLBRAN	C

CASTALIA	C	CHAPMAN		CHIQUITO	C/D	CLEGG	B	COLLEEN	C
CASTANA	B	CHAPPELL	B	CHIRICAHUA	D	CLEMAN	B	COLLEGIATE	C
CASTELL	C	CHARD	B	CHISPA	B	CLEMS	B	COLLETT	C
CASTILE	B	CHARGO	D	CHITINA	B	CLEMVILLE	B	COLLIER	A
CASTINO	C	CHARITON	D	CHITTENDEN	C	CLEORA	B	COLLINGTON	B
CASTLE	D	CHARITY	D	CHITWOOD	C	CLERF	C	COLLINS	C
CASTLEVALE	D	CHARLEBOIS	C	CHIVATO	D	CLERMONT	D	COLLINSTON	C
CASTNER	C	CHARLESTON	C	CHIWAWA	B	CLEVERLY	B	COLLINSVILLE	C
CASTO	C	CHARLEVOIX	B	CHO	C	CLICK	A	COLMA	B
CASTRO	C	CHARLOS	A	CHOBEE	D	CLIFFDOWN	B	COLMOR	B
CASTROVILLE	B	CHARLOTTE	A/D	CHOCK	B/D	CLIFFHOUSE	C	COLD	B
CASUSE	D	CHARLTON	B	CHOCOLODDO	B	CLIFFORD	B	COLOCKUM	B
CASWELL	D	CHASE	C	CHOPAKA	C	CLIFFWOOD	C	COLOMA	A
CATALINA	B	CHASEBURG	B	CHOPTANK	A	CLIFTERSON	B	COLOMBO	B
CATALPA	C	CHASEVILLE	A	CHOPTIE	D	CLIFTON	C	COLONA	C
CATANO	A	CHASKA	C	CHORALMONT	B	CLIFTY	B	COLONIE	A
CATARINA	D	CHASTAIN	D	CHOSKA	B	CLIMARA	D	COLORADO	B
CATAULA	C	CHATBURN	B	CHOTEAU	C	CLIMAX	D	COLOROCK	D
CATAWBA	B	CHATFIELD	C	CHRISTIAN	C	CLIME	C	COLOSO	D
CATH	D	CHATHAM	B	CHRISTIANA	B	CLINTON	B	COLOSSE	A
CATHCARI	C	CHATSWORTH	D	CHRISTIANBURG	D	CLIPPER	B/C	COLP	D
CATHEDRAL	D	CHAUNCEY	C	CHRISTY	B	CLODINE	D	COLRAIN	B
CATHERINE	B/D	CHAVIES	B	CHROME	C	CLONTARF	B	COLTON	A
CATHRO	D	CHAWANAKEE	C	CHUALAR	B	CLOQUALLUM	C	COLTS NECK	B
CATLET	C/D	CHEADLE	C	CHUBBS	C	CLOQUATO	B	COLUMBIA	B
CATLIN	B	CHECKETT	D	CHUCKAWALLA	B	CLOQUET	B	COLUMBINE	A
CATNIP	D	CHEDEHAP	B	CHUGTER	B	CLOUD	D	COLUSA	C
CATOCTIN	C	CHEEKTOWAGA	D	CHULITNA	B	CLOUDCROFT	D	COLVILLE	B/C
CATOOSA	B	CHEESEMAN	C	CHUMMY	C/D	CLOUD PEAK	C	COLVIN	C
CATSKILL	A	CHEHALEM	C	CHUMSTICK	C	CLOUD RIM	B	COLWOOD	B/D
CATTARAUGUS	C	CHEHALIS	B	CHUPADERA	C	CLOUGH	D	COLY	B
CAUDLE	B	CHEHULPUM	D	CHURCH	D	CLOVERDALE	D	COLYER	C/D
CAVAL	B	CHELAN	B	CHURCHILL	D	CLOVER SPRINGS	B	COMER	B
CAVE	D	CHELSEA	A	CHURCHVILLE	D	CLOVIS	B	COMERID	B
CAVELT	D	CHEMAWA	B	CHURN	B	CLUFF	C	COMETA	D
CAVE ROCK	A	CHEMUNG		CHURNDASHER	B	CLUNIE	D	COMFREY	C
CAVO	D	CHEN	D	CHUTE	A	CLURDE	C	COMITAS	A
CAVODE	C	CHENA	A	CIALES	D	CLURO	C	COMLY	C

CAVOUR	D	CHENANGO	A	CIBEQUE	B	CLYDE	D	COMMERCE	C
CAWKER	B	CHENEY	B	CIBO	D	CLYMER	B	COMO	A
CAYAGUA	C	CHENNEBY	C	CIBOLA	B	COACHELLA	B	COMODORE	B
CAYLOR	B	CHENOWETH	B	CICERO	D	COAD	B	COMORO	B
CAYUGA	C	CHEQUEST	C	CIDRAL	C	COAL CREEK	D	COMPTOHE	B
CAZADERO	C	CHEREETE	A	CIENEBA	C	COALMONT	C	COMPTON	C
CAZADOR	B	CHERIONI	D	CIMA	C	COAMO	C	COMSTOCK	C
CAZENOVIA	B	CHEROKEE	D	CIMARRON	C	COARSEGOLD	B/C	COMUS	B
CEBOLIA	C	CHERRY	C	CINCINNATI	C	COATICOOK	C	CONALB	B
CEBONE	C	CHERRYHILL	B	CINCO	A	COATSBURG	D	CONANT	C
CECIL	B	CHERRY SPRINGS	C	CINDERCONE	B	COBB	B	CONASAUGA	C
CEDA	B	CHESAW	A	CINEBAR	B	COBEN	D	CONATA	D
CEDARAN	D	CHESHIRE	B	CINTRONA	D	COBEY	B	CONBOY	D
CEDAR BUTTE	C	CHESHNINA	C	CIPRIANO	D	COBURG	C	CONOHAS	C
CEDAREDGE	B	CHESNIMNUS	B	CIRCLE	C	COCHETOPA	C	CONCHO	C
CEDAR MOUNTAIN	D	CHESTER	B	CIRCLEVILLE	C	COCOA	A	CONCONULLY	B
CEDARVILLE	B	CHESTERTON	C	CISNE	D	COCOLALLA	C	CONCORD	D
CEDONIA	B	CHETCO	D	CISPUS	A	CODORUS	C	CONCREEK	B
CEDRON	C/D	CHETEK	B	CITICO	B	CODY	A	CONDA	C
CELAYA	B	CHEVELON	C	CLACKAMAS	C	COE	A	CONDIT	D
CELETON	D	CHEWACLA	C	CLAIBORNE	B	COEBURN	C	CONDON	C
CELINA	C	CHEWELAH	B	CLAIRE	A	COEROCK	D	CONE	A
CELIO	A/D	CHEYENNE	B	CLAIREMONT	B	COFF	D	CONEJO	C
CELLAR	D	CHIARA	D	CLALLAM	C	COFFEEK	B	CONESTOGA	B
CENCOVE	B	CHICKASHA	B	CLAM GULCH	D	COGGON	B	CONESUS	B
CENTER	C	CHICOPEE	B	CLAMO	C	COGSWELL	C	CONGAREE	B
CENTER CREEK	B	CHICOTE	D	CLANTON	C	COHASSET	B	CONGER	B
CENTERFIELD	B	CHIGLEY	C	CLAPPER	B	COHOCTAH	D	CONI	D
CENTERVILLE	D	CHILCOTT	D	CLAREMORE	D	COHOE	B	CONKLIN	B
CENTRALIA	B	CHILOS	B	CLARENCE	D	COIT	C	CONLEN	B
CONLEY	C	COURT	B	CROWLEY	D	DANSKIN	B	DELLROSE	B
CONNEAUT	C	COURTHOUSE	D	CROWN	B	DANT	D	DELM	D
CONNECTICUT		COURTLAND	B	CROWSHAW	B	DANVERS	C	DELMAR	D
CONNERTON	B	COURTNEY	D	CROZIER	C	DANVILLE	C	DELMITA	C
CONOTTON	B	COURTROCK	B	CRUCES	D	DANZ	B	DELMONT	B
CONOVER	B	COUSE	C	CRUCKTON	B	DARCO	A	DELMORTE	C
CONOWINGO	C	COUSHATTA	B	CRUICKSHANK	C	DARGOL	D	DELPHI	B
CONRAD	B	COVE	D	CRUME	B	DARIEN	C	DELPHILL	C

CONROE	B	COVEILO	B	CRUMP	D	DARLING	B	DELPIEDRA	C
CONSER	C/D	COVELAND	C	CRUTCH	B	DARNELL	C	DELPINE	D
CONSTABLE	A	COVELLO	B/C	CRUTCHER	D	DARNEN	B	DELRAY	A/D
CONSTANCIA	D	COVENTRY	B	CRUZE	C	DARR	A	DEL REY	C
CONSUMO	B	COVEYTOWN	C	CRYSTAL LAKE	B	DARRET	C	DEL RIO	B
CONTEE	D	COVINGTON	D	CRYSTAL SPRINGS	D	DARROCH	C	DELSON	C
CONTINE	C	COWAN	A	CRYSTOLA	B	DARROUZETT	C	DELTA	C
CONTINENTAL	C	COWARTS	C	CUBA	B	DART	A	DELTON	B
CONTRA COSTA	C	COWDEN	D	CUBERANT	B	DARVADA	D	DELWIN	A
CONVENT	C	COWDREY	C	CUCHILLAS	D	DARWIN	D	DELYNDIA	A
COOK	D	COWEEMAN	D	CUDAHY	D	DASSEL	D	DEMAST	B
COOKPORT	C	COWERS	B	CUERO	B	DAST	C	DE MASTERS	B
COOLBRITH	B	COWETA	C	CUEVA	D	DATEMAN	C	DE MAYA	C
COOLIDGE	B	COWICHE	B	CUEVITAS	D	DATINO	C	DEMERS	D
COOLVILLE	C	COWOOD	C	CULBERTSON	B	DATWYLER	C	DEMKY	D
COOMBS	B	COX	D	CULLEN	C	DAULTON	D	DEMONA	C
COONEY	B	COXVILLE	D	CULLEOKA	B	DAUPHIN		DEMOPOLIS	C
COOPER	C	COY	D	CULLO	C	DAVEY	A	DEMPSEY	B
COOTER	C	COYATA	C	CULPEPER	C	DAVIDSON	B	DEMPSTER	B
COPAKE	B	COZAD	B	CULVERS	C	DAVIS	B	DENAY	B
COPALIS	B	CRABTON	B	CUMBERLAND	B	DAVISON	B	DENHAWKEN	D
COPELAND	B/D	CRADDOCK	B	CUMLEY	C	DAVTONE	B	DENISON	C
COPITA	B	CRADLEBAUGH	D	CUMMINGS	B/D	DAWES	C	DENMARK	D
COPLAY		CRAFTON	C	CUNDIYO	B	DAWHOO	B/D	DENNIS	C
COPPER RIVER	D	CRAGO	B	CUNICO	C	DAWSON	D	DENNY	D
COPPERTON	B	CRAGOLA	D	CUPPER	B	DAXTY	C	DENROCK	D
COPPOCK	B	CRAIG	C	CURANT	B	DAY	D	DENTON	D
COPSEY	D	CRAIGMONT	C	CURDLI	C	DAYBELL	A	DENVER	C
COQUILLE	C/D	CRAIGSVILLE	A	CURECANTI	B	DAYTON	D	DEDDAR	D
CORA	D	CRAMER	D	CURHOLLOW	D	DAYVILLE	B/C	DEPEW	C
CORAL	C	CRANE	B	CURLEW	C	DAZE	D	DEPOE	D
CORBETT	B	CRANSTON	B	CURRAN	C	DEACON	B	DEPORT	D
CORBIN	B	CRARY	C	CURTIS CREEK	D	DEADFALL	B	DERA	B
CORCEGA	C	CRATER LAKE	B	CURTIS SIDING	A	DEAMA	C	DERINDA	C
CORD	C	CRAVEN	C	CUSHING	B	DEAN	C	DERR	C
CORDES	B	CRAWFORD	D	CUSHMAN	C	DEAN LAKE	C	DERRICK	B
CORDOVA	C	CREAL	D	CUSTER	C	DEARDURFF	B	DESAN	A
CORINTH	C	CREDDIN	C	CUTTER	D	DEARY	C	DESART	C

CORKINDALE	B	CREDO	C	CUTZ	D	DEARYTON	B	DESCALABRADO	D
CORLENA	A	CREEDMAN	DS	CUYAMA	B	DEATMAN	C	DESCHUTES	C
CORLETT	B	CREEDMOOR	C	CUYON	A	DEAVER	C	DESERET	C
CORLEY	C	CREIGHTON	B	CYAN	D	DEBENGER	C	DESERTER	B
CORMANT	C	CRELDON	B	CYLINDER	B	DEBORAH	D	DESHA	D
CORNHILL	B	CRESBARD	C	CYNTHIANA	C/D	DECAN	D	DESHLER	C
CORNING	D	CRESCENT	B	CYPREMORT	C	DECATHON	D	DESOLATION	C
CORNISH	B	CRESCO	C	CYRIL	B	DECATUR	B	DESPAIN	B
CORNUTT	C	CRESPIN	C			DECCA	B	DETER	C
CORNVILLE	B	CREST	C	DABOB	B	DECKER	C	DETLOR	C
COROZAL	C	CRESTLINE	B	DACONO	C	DECKERVILLE	C	DETOUR	C
CORPENING	D	CRESTMORE		DACOSTA	D	DECLO	B	DETRA	B
CORRALITOS	A	CRESTON	A	DADE	A	DECORRA	B	DETROIT	C
CORRECO	C	CRESWELL	C	DAFTER	B	DECROSS	B	DEV	B
CORRERA	D	CRETE	D	DAGFLAT	C	DEE	C	DEVILS DIVE	D
CORSON	C	CREVA	D	DAGGETT	A	DEEPWATER	C	DEVOE	D
CORTADA	B	CREVASSE	A	DAGLUM	D	DEER CREEK	C	DEVOIGNES	C/D
CORTEZ	D	CREWS	D	DAGOR	B	DEERFIELD	B	DEVOL	B
CORTINA	A	CRIDER	B	DAGUAO	C	DEERFORD	D	DEVON	B
CORUNNA	D	CRIM	B	DAGUEY	C	DEERING	B	DEVORE	B
CORVALLIS	B	CRISFIELD	B	DAHLQUIST	B	DEERLODGE	D	DEVOY	D
CORWIN	B	CRITCHELL	B	DAIGLE	C	DEER PARK	A	DEWARD	
CORY	C	CRIVITZ	A	DAILEY	A	DEERTON	B	DEWEY	B
CORYDON	C	CROCKER	A	DAKOTA	B	DEERTRAIL	C	DEWVILLE	B
COSAD	C	CROCKETT	D	DALBO	B	DEFIANCE	D	DEXTER	B
COSH	C	CROESUS	C	DALBY	D	DEFORD	D	DIA	C
COSHOCTON	C	CROFTON	B	DALCAN	C	DEGARMO	B/C	DIABLO	D
COSKI	B	CROGHAN	B	DALE	B	DEGNER	C	DIAMOND	D
COSSAYUNA	C	CROOKED	C	DALHART	B	DE GREY	D	DIAMOND SPRINGS	C
COSTILLA	A	CROOKED CREEK	D	DALIAN	B	DEJARNET	B	DIAMONDVILLE	C
COTACO	C	CROOKSTON	B	DALLAM	B	DEKALB	C	DIANEV	C
COTATI	C	CROOM	B	DALTON	C	DEKOVEN	D	DIANOLA	D
COTITO	C	CROPLEY	D	DALUPE	B	DELA	B	DIAZ	C
COTO	C	CROSBY	C	DAMASCUS	D	DELAKE	B	DIBBLE	C
COTOPAXI	A	CROSS	D	DAMON	D	DELANCO	C	DICK	A
COTT	B	CROSSVILLE	B	DANA	B	DELANEY	A	DICKEY	A
COTTER	B	CROSWELL	A	DANBURY	C	DELANO	B/C	DICKINSON	C
COTTERAL	B	CROT	D	DANBY		DELECO	D	DICKSON	C

COTTIER	B	CROTON	D	DANDREA	C	DELENA	D	DIGBY	C
COTTONWOOD	C	CROUCH	B	DANDRIDGE	D	DELFINA	B	DIGGER	C
COTTRELL	C	CROW	C	DANGBERG	D	DELHI	A	DIGHTON	B
COUCH	C	CROW CREEK	B	DANIC	C	DELICIAS	B	DILL	B
COUGAR	D	CROWFOOT	B	DANIELS	B	DELKS	B/D	DILLARD	C
COULSTONE	B	CROWHEART	D	DANKO	D	DELL	C	DILLDOWN	
COUNTS	C	CROW HEART	D	DANLEY	C	DELLEKER	B	DILLINGER	B
COUPEVILLE	C	CROW HILL	C	DANNEMORA	D	DELLO	A/C	DILLON	D
DILLWYN	A	DOUGHTY	A	DU PAGE	B	EGBERT	B/C	EMILY	B
DILMAN	C	DOUGLAS	B	DUPEE	C	EGELAND	B	EMLIN	B
DILTS	D	DOURO	B	DUPLIN	C	EGGLESTON	B	EMMA	C
DILWORTH	D	DOVER	B	DUPO	C	EGNAR	C	EMMERT	A
DIMAL	D	DOVRAY	D	DUPONT	D	EICKS	C	EMMET	B
DIMYAW	C	DOW	B	DUPREE	D	EIFORT	C	EMMONS	C
DINGLE	B	DOWAGIAC	B	DURALDE	C	EKAH	C	EMORY	B
DINGLISHNA	D	DOWDEN	C	DURAND	B	EKALAKA	B	EMPEDRADO	C
DINKELMAN	B	DOWELLTON	D	DURANT	D	ELAM	A	EMPEY	B
DINKEY	A	DOWNER	B	DURELLE	B	ELBERT	D	EMPEYVILLE	C
DINNEN	B	DOWNEY	B	DURHAM	B	ELBURN	B	EMPIRE	C
DINSDALE	B	DOWNS	B	DURKEE	C	ELCO	B	EMRICK	B
DINUBA	B/C	DOXIE	C	DUROC	B	ELD	B	ENCE	B
DINZER	B	DOYCE	C	DURRSTEIN	D	ELDER	B	ENCIERRO	D
DIOXICE	B	DOYLE	A	DUSTON	B	ELDER HOLLOW	D	ENCINA	B
DIPMAN	D	DOYLESTOWN	D	DUTCHESS	B	ELDERON	B	ENDERS	C
DIQUE	B	DOYN	C	DUTSON	D	ELDON	B	ENDERSBY	B
DISABEL	D	DRA	C	DUTTON	D	ELDORADO	C	ENDICOTT	C
DISAUTEL	B	DRACUT	C	DUVAL	B	ELDRIDGE	C	ENET	B
DISCO	B	DRAGE	B	DZEL	B	ELEPHANT	D	ENFIELD	B
DISHNER	D	DRAGOON	B	DWIGHT	D	ELEROY	B	ENGLE	B
DISTERHEFF	C	DRAGSTON	C	DWYER	A	ELFRIDA	B	ENGLESIDE	B
DITCHCAMP	C	DRAHAT	D	DYE	D	ELIJAH	C	ENGLEWOOD	C
DITHOD	C	DRAIN	D	DYER		ELIOAK	C	ENGLUND	D
DIVERS	B	DRAKE	B	DYKE	B	ELK	B	ENNIS	B
DIVIDE	B	DRANYON	B	DYRENG	D	ELKADER	B	ENOCHVILLE	B/D
DIX	A	DRAPER	C			ELKCREEK	C	ENOLA	B
DIXIE	C	DRESDEN	B	EACHUSTON	D	ELK HOLLOW	B	ENON	C
DIXMONT	C	DRESSLER	C	EAD	C	ELKHORN	B	ENOREE	D
DIXMORE	B	DREWS	B	EAGAR	B	ELKINS	D	ENOS	B

DIXONVILLE	C	DREXEL	B	EAGLECONE	B	ELKINSVILLE	B	ENOSBURG	D
DIXVILLE	A	DRIFTON	C	EAKIN	B	ELKMOUND	C	ENSENADA	B
DOAK	B	DRIGGS	B	EAMES	B	ELK MOUNTAIN	B	ENSIGN	D
DOBBS	C	DRUM	C	EARLE	D	ELKOL	D	ENSLEY	D
DOBEL	D	DRUMMER	B	EARLMONT	B/C	ELKTON	D	ENSTROM	B
DOBROW	D	DRUMMOND	D	EARP	B	ELLABELLE	B/D	ENTENTE	B
DOBY	D	DRURY	B	EASLEY	D	ELLEDGE	C	ENTERPRISE	B
DOCAS	B	DRYAD	C	EAST FORK	C	ELLERY	D	ENTIAT	D
DOCKERY	C	DRYBURG	B	EAST LAKE	A	ELLETT	D	ENUMCLAW	C
DOCT	B	DRY CREEK	C	EASTLAND	C	ELLIBER	A	EPHRAIM	C
DODGE	B	DRYDEN	B	EASTON	C	ELLICOTT	A	EPHRATA	B
DODGEVILLE	B	DRY LAKE	C	EASTONVILLE	A	ELLINGTON	B	EPLEY	B
DODSON	C	DUANE	B	EAST PARK	D	ELLINOR	C	EPOUFETTE	D
DOGER	A	DUART	C	EASTPORT	A	ELLIOTT	C	EPPING	D
DOGUE	C	DUDAXELLA	C	EATONTOWN		ELLIS	D	EPSIE	D
DOLAND	B	DUBAY	D	EAUGALLIE	B/D	ELLISFORDE	C	ERA	B
DOLE	C	DUBBS	B	EBA	C	ELLISON	B	ERAM	C
DOLLAR	B	DUBOIS	C	EBBERT	D	ELLOAM	D	ERBER	C
DOLLARD	C	DUBUQUE	B	EBBS	B	ELLSBERRY	C	ERIC	B
DOLORES	B	DUCEY	B	EBENEZER	C	ELLSWORTH	C	ERIE	C
DOLPH	C	DUCHESNE	B	ECCLES	B	ELLUM	C	ERIN	B
DUMEZ	C	DUCKETT	C	ECHARD	C	ELMA	B	ERNEST	C
DOMINGO	C	DUCOR	D	ECHLER	B	ELMDALE	B	ERNO	B
DOMINGUEZ	C	DUDA	A	ECKERT	D	ELMENDORF	D	ERRAMOUSPE	C
DOMINIC	A	DUDLEY	D	ECKLEY	B	ELMIRA	A	ESCABOSA	C
DOMINO	C	DUEL	B	ECKMAN	B	ELMO	C	ESCAL	B
DOMINSON	A	DUELM	C	ECKRANT	D	ELMONT	B	ESCALANTE	B
DONA ANA	B	DUFFAU	B	ECTOR	D	ELMORE	B	ESCAMBIA	C
DONAHUE	C	DUFFER	D	EDALGO	C	ELMWOOD	C	ESCONDIDO	C
DONALD	B	DUFFIELD	B	EDDS	B	ELNORA	B	ESMOND	B
DONAVAN	B	DUFFSON	B	EDDY	C	ELOIKA	B	ESPARTO	B
DONEGAL		DUFFY	B	EDEN	C	ELPAN	D	ESPIL	D
DONERAIL	C	DUFUR	B	EDENTON	C	EL PECO	C	EPINAL	A
DONEY	C	DUGGINS	D	EDENVALE	D	EL RANCHO	B	ESPLIN	D
DONICA	A	DUGOUT	D	EDGAR	B	ELRED	B/D	ESPY	C
DONLONTON	C	DUGWAY	D	EDGECUMBE	B	ELROSE	B	ESQUATZEL	B
DONNA	D	DUKES	A	EDGELEY	C	ELS	A	ESS	B
DONNAN	C	DULAC	C	EDGEMONT	B	ELSAH	B	ESSEN	C

DONNAROO	B	DUMAS	B	EDGEWATER	C	ELSINBORO	B	ESSEX	C
DONNYBROOK	D	DUMECO	C	EDGEWICK	B	ELSINORE	A	ESSEXVILLE	D
DONOVAN	B	DUMONT	B	EDGEWOOD	A	ELSMERE	A	ESTACADO	B
DOOLEY	A	DUNBAR	D	EDGINGTON	C	ELSO	D	ESTELLINE	B
DOONE	B	DUNBARTON	C	EDINA	D	EL SOLYO	C	ESTER	D
DOOR	B	DUNBRIDGE	B	EDINBURG	C	ELSTON	B	ESTERBROOK	B
DORA	D	DUNCAN	D	EDISON	B	ELTOPIA	B	ESTHERVILLE	B
DORAN	C	DUNCANNON	B	EDISTO	C	ELTREE	B	ESTIVE	C
DORCHESTER	B	DUNCOM	D	EDITH	A	ELTSAC	D	ESTO	B
DOROSHIN	D	DUNDAS	C	EDLOE	B	ELWHA	B	ESTRELLA	B
DOROTHEA	C	DUNDAY	A	EDMONDS	D	ELWOOD	C	ETHAN	B
DOROVAN	D	DUNDEE	C	EDMORE	D	ELY	B	ETHETE	B
DORS	B	DUNELLEN	B	EDMUND	C	ELYSIAN	B	ETHRIDGE	C
DORSET	B	DUNE SAND	A	EDNA	D	ELZINGA	B	ETIL	A
DOS CABEZAS	C	DUNGENESS	B	EDNEYVILLE	B	EMBDEN	B	ETNA	
DOSS	C	DUN GLEN	C	EDOM	C	EMBRY	B	ETOE	B
DUSSMAN	B	DUNKINSVILLE	B	EDROY	D	EMBUDO	B	ETOWAH	B
DOTEN	D	DUNKIRK	B	EDSON	C	EMDENT	C	ETOWN	B
DOTHAN	B	DUNLAP	B	EDWARDS	B/D	EMER	C	ETSEL	D
DOTTA	B	DUNMORE	B	EEL	C	EMERALD	B	ETTA	C
DOTY	B	DUNNING	D	EFFINGTON	D	EMERSON	B	ETTER	B
DOUBLETOP	B	DUNPHY	D	EFWUN	A	EMIDA	D	ETTERSBURG	B
DOUDS	B	DUNUL	A	EGAM	C	EMIGRANT	B	ETTRICK	D
DOUGHERTY	A	DUNVILLE	B	EGAN	B	EMIGRATION	D	EUBANKS	B
EUDORA	B	FE	D	FLOWELL	C	FRENCH	C	GARLOCK	C
EUFAULA	A	FEDORA	B	FLOWEREE	B	FRENCHTOWN	D	GARMON	C
EUREKA	D	FELAN	A	FLOYD	B	FRENEAU	C	GARMORE	B
EUSTIS	A	FELDA	B/D	FLUETSCH	C	FRESNO	C/D	GARNER	D
EUTAW	D	FELIDA	B	FLUSHING		FRIANA	D	GARO	D
EVANGELINE	C	FELKER	D	FLUVANNA	C	FRIANT	D	GARR	D
EVANS	B	FELLOWSHIP	D	FLYGARE	B	FRIDLO	C	GARRARD	B
EVANSTON	B	FELT	B	FLYNN	D	FRIEDMAN	B	GARRETSON	B
EVARO	A	FELTA	C	FOARD	D	FRIENDS	D	GARRETT	B
EVART	D	FELTHAM	A	FOGELSVILLE	B	FRIES	D	GARRISON	B
EVENDALE	C	FELTON	B	FOLA	B	FRINDLE	B	GARTON	C
EVERETT	B	FELTONIA	B	FOLEY	D	FRIO	B	GARWIN	C
EVERGLADES	A/D	FENCE	B	FONDA	D	FRIZZELL	C	GASCONADE	D
EVERLY	B	FENDALL	C	FONDIS	C	FROBERG	D	GAS CREEK	C

EVERMAN	C
EVERSON	D
EVESBORO	A
EWA	B
EWAIL	A
EWALL	A
EWINGSVILLE	B
EXCELSIOR	B
EXCHEQUER	D
EXETER	C/D
EXLINE	D
EXRAY	D
EXUM	C
EYERBOW	D
EYRE	B
FABIUS	B
FACEVILLE	B
FAHEY	B
FAIM	C
FAINES	A
FAIRBANKS	B
FAIRDALE	B
FAIRFAX	B
FAIRFIELD	B
FAIRHAVEN	B
FAIRMOUNT	D
FAIRPORT	C
FAIRYDELL	C
FAJARDO	C
FALAYA	C
FALCON	D
FALFA	C
FALFURRIAS	A
FALK	B
FALKNER	C
FALL	B
FALLBROOK	B/C
FENWOOD	B
FERA	C
FERDELFORD	C
FERDIG	C
FERDINAND	C
FERGUS	B
FERGUSON	B
FERNANDO	B
FERN CLIFF	B
FERNDALE	B
FERNLEY	C
FERNOW	B
FERNPOINT	C
FERRELO	B
FERRIS	D
FERRON	D
FERTALINE	D
FESTINA	B
FETT	D
FETTIC	D
FIANDER	C
FIBEA	D
FIDALGO	C
FIDDLETOWN	C
FIDDYMENT	C
FIELDING	B
FIELDON	B
FIELDSON	A
FIFE	B
FIFER	D
FILLMORE	D
FINCASTLE	C
FINGAL	C
FINLEY	B
FIRESTEEL	B
FIRGRELL	B
FIRMAGE	B
FIRO	D
FONTAL	D
FONTREEN	B
FOPIANO	D
FORBES	B
FORD	D
FORDNEY	A
FORDTRAN	C
FORDVILLE	B
FORE	D
FORELAND	D
FORELLE	B
FORESMAN	B
FORESTDALE	D
FORESTER	C
FORESTON	C
FORGAY	A
FORMAN	B
FORNEY	D
FORREST	C
FORSEY	C
FORSGREN	C
FORT COLLINS	B
FORT DRUM	C
FORT LYON	B
FORT MEADE	A
FORT MOTT	A
FORT PIERCE	C
FORT ROCK	C
FORTUNA	D
FORTWINGATE	C
FORWARD	C
FOSHOME	B
FOSSUM	B
FOSTER	B/C
FOSTORIA	B
FOUNTAIN	D
FOURLOG	D
FOURMILE	B
FROHMAN	C
FRONDORF	C
FRONHOFER	C
FRONTON	D
FROST	D
FRUITA	B
FRUITLAND	B
FRYE	C
FUEGO	C
FUERA	C
FUGAWEE	B
FULCHER	C
FULDA	C
FULLERTON	B
FULMER	B/D
FULSHEAR	C
FULTON	D
FUQUAY	B
FURNISS	B/D
FURY	B/D
FUSULINA	C
GAASTRA	C
GABALDON	B
GABBS	D
GABEL	C
GABICA	D
GACEY	D
GACHADO	D
GADDES	C
GADES	G
GADSDEN	D
GAGE	
GAGEBY	B
GAGETOWN	C
GAHEE	B
GAINES	C
GAINESVILLE	A
GASKELL	C
GASS	D
GASSET	D
GATESBURG	A
GATESON	C
GATEVIEW	B
GATEWAY	C
GATEWOOD	D
GAULDY	B
GAVINS	C
GAVIOTA	D
GAY	D
GAYLORD	B
GAYNOR	C
GAYVILLE	B
GAZELLE	D
GAZOS	B
GEARHART	A
GEARY	B
GEL	B
GEEBURG	C
GEER	C
GEFO	A
GELKIE	B
GEM	C
GEMID	C
GEMSON	C
GENESEE	B
GENEVA	C
GENOA	D
GENOLA	B
GEORGEVILLE	B
GEORGIA	B
GERALD	D
GERBER	D
GERIG	B
GERING	B
GERLAND	C

FALLON	C	FIRTH	B/C	FOUR STAR	B/C	GALATA	D	GERMANIA	
FALLSBURG	C	FISH CREEK	B	FOUTS	B	GALE	B	GERMANY	B
FALLSINGTON	D	FISHERS	B	FOX	B	GALEN	B	GERRARD	D
FANCHER	C	FISHHOOK	D	FOXCREEK	B/D	GALENA	C	GESTRIN	B
FANG	B	FISHKILL		FOXMOUNT	C	GALEPPI	C	GETTA	C
FANNIN	B	FITCH	A	FOXOL	D	GALESTOWN	A	GETTYS	C
FANNO	C	FITCHVILLE	C	FOXPARK	D	GALETON	D	GEYSEN	D
FANU	C	FITZGERALD	B	FOX PARK	D	GALEY	B	GHENT	C
FARADAY	B	FITZHUGH	B	FOXTON	C	GALISTED	C	GIBBLER	C
FARALLONE	B	FIVE DOT	B	FRAILEY	B	GALLAGHER	B	GIBBON	B
FARAWAY	D	FIVEMILE	B	FRAM	B	GALLATIN	A	GIBBS	D
FARB	D	FIVES	B	FRANCIS	A	GALLEGOS	B	GIBBSTOWN	A
FARGO	D	FLAGG	B	FRANCITAS	D	GALLINA	C	GIFFIN	C
FARISITA	C	FLAGSTAFF	C	FRANK	D	GALLION	B	GIFFORD	C
FARLAND	B	FLAK	B	FRANKFORT	D	GALVA	B	GILA	B
FARMINGTON	C/D	FLAMING	B	FRANKIRK	C	GALVESTON	A	GILBY	B
FARNHAM	B	FLAMINGO	D	FRANKLIN	B	GALVEZ	C	GILCHRIST	B
FARNHAMTON	B/C	FLANAGAN	B	FRANKSTOWN	B	GALVIN	C	GILCREST	B
FARNUF	B	FLANDREAU	B	FRANKTOWN	D	GALWAY	B	GILEAD	C
FARNUM	B	FLASHER	A	FRANKVILLE	B	GAMBLER	A	GILES	B
FARRAGUT	C	FLATHEAD	A	FRATERNIDAD	D	GAMBOA	B	GILFORD	B/D
FARRAR	B	FLAT HORN	B	FRAZER	C	GANNETT	D	GILHOULY	B
FARRELL	B	FLATTOP	D	FRED	C	GANSNER	D	GILISPIE	C
FARRENBURG	B	FLATWILLOW	B	FREDENSBORG	C	GAPO	D	GILLIAM	C
FARROT	C	FLAXTON	A	FREDERICK	B	GAPPMAYER	B	GILLIGAN	B
FARSON	B	FLEAK	A	FREDON	C	GARA	B	GILLS	C
FARWELL	C	FLECHADO	B	FREDONIA	C	GARBER	A	GILLSBURG	C
FASKIN	B	FLEER	D	FREDRICKSON	C	GARBUTT	B	GILMAN	B
FATIMA	B	FLEETWOOD		FREEBURG	C	GARCENO	C	GILMORE	C
FATTIG	C	FLEISCHMANN	D	FREECE	D	GARDELLA	D	GILPIN	C
FAUNCE	A	FLEMING	C	FREEDOM	C	GARDENA	B	GILROY	C
FAUQUIER	C	FLETCHER	B	FREEHOLD	B	GARDINER	A	GILSON	B
FAUSSE	D	FLOKE	D	FREEL	B	GARDNER'S FORK	B	GILT EDGE	D
FAWCETT	C	FLOM	C	FREEMAN	C	GARDNERVILLE	D	GINAT	D
FAWN	B	FLOMATION	A	FREEMANVILLE	B	GARDONE	A	GINGER	C
FAXON	D	FLOMOT	B	FREEON	B	GAREY	C	GINI	B
FAYAL	C	FLORENCE	C	FREER	C	GARFIELD	C	GINSER	C

FAYETTE	B
FAYETTEVILLE	B
FAYWOOD	C
GLADDEN	A
GLADE PARK	C
GLADSTONE	B
GLADWIN	A
GLAMIS	C
GLANN	B/C
GLASGOW	C
GLEAN	B
GLEASON	C
GLEN	B
GLENBAR	B
GLENBERG	B
GLENBROOK	D
GLENCOE	D
GLENDALE	B
GLENDIVE	B
GLENDORA	D
GLENELG	B
GLENFIELD	D
GLENFORD	C
GLENHALL	B
GLENHAM	B
GLENMORA	C
GLENNALLEN	C
GLENOMA	B
GLENROSE	B
GLENSTED	D
GLENTON	B
GLENVIEW	B
GLENVILLE	C
GLIDE	B
GLIKON	B
GLORIA	C
GLOUCESTER	A
GLOVER	C/D
FLORESVILLE	C
FLORIDANA	B/D
FLORISSANT	C
GOTHARD	D
GOTHIC	C
GOTHO	C
GOULDING	D
GOVAN	C
GOVE	B
GOWEN	B
GRABE	B
GRABLE	B
GRACEMONT	B
GRACEVILLE	B
GRADY	D
GRAFEN	B
GRAFTON	B
GRAHAM	D
GRAIL	C
GRAMM	B
GRANATH	B
GRANBY	A/D
GRANDE RONDE	D
GRANDFIELD	B
GRANDVIEW	C
GRANER	C
GRANGER	C
GRANGEVILLE	B/C
GRANILE	B
GRANO	D
GRANT	B
GRANTSBURG	C
GRANTSDALE	A
GRANVILLE	B
GRAPEVINE	C
GRASMERE	B
GRASSNA	B
GRASSY BUTTE	A
FREESTONE	C
FREEZENER	C
FREMONT	C
GROWDEN	B
GROWLER	B
GRUBBS	D
GRULLA	D
GRUMMIT	D
GRUNDY	C
GRUVER	C
GRYGLA	C
GUADALUPE	B
GUAJE	A
GUALALA	D
GUAMANI	B
GUANABANO	B
GUANAJIBO	C
GUANICA	D
GUAYABO	B
GUAYABOTA	D
GUAYAMA	D
GUBEN	B
GUCKEEN	C
GUELPH	B
GUENOC	C
GUERNSEY	C
GUERRERO	C
GUEST	D
GUIN	A
GULER	B
GULKANA	B
GUMBOOT	C
GUNBARREL	A
GUNN	B
GUNNUK	C
GUNSIGHT	B
GUNTER	A
GURABO	D
GARITA	C
GARLAND	B
GARLET	A
HAMBRIGHT	D
HAMBURG	B
HAMBY	C
HAMEL	C
HAMERLY	C
HAMILTON	A
HAMLET	B
HAMLIN	B
HAMMONTON	C
HAMPDEN	
HAMPSHIRE	C
HAMPTON	C
HAHTAH	C
HANA	A
HANALEI	C
HANAMAULU	A
HANCEVILLE	B
HANCO	D
HAND	B
HANDRAN	C
HANDSBORO	D
HANDY	D
HANEY	B
HANFORD	B
HANGAARD	C
HANGER	B
HANIPOE	B
HANKINS	C
HANKS	B
HANLY	A
HANNA	B
HANNUM	D
HANOVER	C
HANS	C
HANSEL	C
GIRARDOT	D
GIRD	A
GIVEN	C
HASTINGS	B
HAT	D
HATBORO	D
HATCH	C
HATCHERY	C
HATFIELD	C
HATHAWAY	B
HATTIE	C
HATTON	C
HAUBSTADT	C
HAUGAN	B
HAUSER	D
HAVANA	B
HAVEN	B
HAVERLY	B
HAVERSON	B
HAVILLAH	C
HAVINGDON	D
HAVRE	B
HAVRELON	B
HAW	B
HAWES	A
HAWI	B
HAWKEYE	A
HAWKSELL	A
HAWKSPRINGS	B
HAXTUN	A
HAYBOURNE	B
HAYBRO	C
HAYDEN	B
HAYESTON	B
HAYESVILLE	B
HAYFIELD	B
HAYFORD	C
HAYMOND	B

GLYNDON	B	GRATZ	C	GURNEY	C	HANSKA	C	HAYNESS	B
GLYNN	C	GRAVDEN	C	GUSTAVUS	D	HANSON	A	HAYNIE	B
GOBLE	C	GRAVE	B	GUSTIN	C	HANTHO	B	HAYPRESS	A
GODDARD	B	GRAVITY	C	GUTHRIE	D	HANTZ	D	HAYSPUR	B/D
GODDE	D	GRAYCALM	A	GUYTON	D	HAP	B	HAYTER	B
GODECKE	D	GRAYFORD	B	GWIN	D	HAPGOOD	B	HAYTI	D
GODFREY	C	GRAYLING	A	GWINNETT	B	HAPNEY	C	HAYWOOD	B
GODWIN	D	GRAYLOCK	B	GYMER	C	HARBORO	B	HAZEL	C
GOEGLEIN	C	GRAYPOINT	B	GYPSTRUM	B	HARBOURTON		HAZELAIR	D
GOESSEL	D	GRAYS	B			HARCO	B	HAZEN	B
GOFF	C	GREAT BEND	B	HACCKE	C	HARDEMAN	B	HAZLEHURST	C
GOGEBIC	B	GREELEY	B	HACIENDA	D	HARDESTY	B	HAZLETON	B
GOLBIN	C	GREEN BLUFF	B	HACK	B	HARDING	D	HAZTON	D
GOLCONDA	D	GREENBRAE	C	HACKERS	B	HARDSCRABBLE	B	HEADLEY	B
GOLD CREEK	D	GREEN CANYON	B	HACKETTSTOWN	B	HARDY	D	HEADQUARTERS	B
GOLDENDALE	B	GREENCREEK	B	HADAR	A	HARGREAVE	B	HEAKE	D
GOLDFIELD	B	GREENDALE	B	HADES	C	HARKERS	C	HEATH	C
GOLDHILL	B	GREENFIELD	B	HADLEY	B	HARKEY	B	HEATLY	A
GOLDMAN	C	GREENHORN	B			HARLAN	B	HEBBRONVILLE	B
GOLDRIDGE	B	GREENLEAF	B	HAGEN	B	HARLEM	C	HEBER	B
GOLDRUN	A	GREENOUGH	C	HAGENBARTH	B	HARLESTON	C	HEBERT	C
GOLDSBORO	C	GREENPORT		HAGENER	A	HARLINGEN	D	HEBGEN	A
GOLDSTON	C	GREEN RIVER	B	HAGER	C	HARMEHL	C	HEBO	D
GOLDSTREAM	D	GREENSBORO		HAGERMAN	C	HARMONY	C	HEBRON	C
GOLDVALE	C	GREENSON	C	HAGERSTOWN	C	HARNEY	C	HECHT	C
GOLDVEIN	C	GREENTON	C	HAGGA	B	HARPER	D	HECKI	C
GOLIAD	C	GREENVILLE	B	HAGGERTY	B	HARPETH	B	HECLA	B
GOLLAHER	A	GREENWATER	A	HAGSTADT	C	HARPS	B	HECTOR	D
GOLTRY	A	GREENWICH	B	HAGUE	A	HARPSTER	C	HEDDEN	C
GOMEZ	B	GREENWOOD	D	HAIG	C	HARPT	B	HEDRICK	B
GOMM	D	GREER	C	HAIKU	B	HARQUA	C	HEDVILLE	D
GONVICK	B	GREGORY	A	HAILMAN	B	HARRIET	D	HEGNE	D
GOOCH	D	GREHALEM	B	HAINES	B/C	HARRIMAN	B	HEIDEN	D
GOODALE	C	GRELL	D	HAIRE	C	HARRIS	D	HEIDTMAN	C
GOODING	C	GRENADA	C	HALAWA	B	HARRISBURG	D	HEIL	D
GOODINGTON	C	GRENVILLE	B	HALDER	C	HARRISON	C	HEIMDAL	B
GOODLOW	B	GRESHAM	C	HALE	B	HARRISVILLE	C	HEISETON	B
GOODMAN	B	GREWINGK	D	HALEDON	C	HARSTENE	B	HEISLER	B

GOODRICH	B	GREYBACK	B	HALEIWA	B	HARSTINE	C	HEIST	B
GOODSPRINGS	D	GREYBULL	C	HALEY	B	HART	D	HEITT	C
GOOSE CREEK	B	GREYCLIFF	C	HALF MOON	B	HART CAMP	C	HEITZ	D
GOOSE LAKE	D	GREYS	B	HALFORD	A	HARTFORD	A	HEIZER	D
GOOSMUS	B	GRIFFY	B	HALFWAY	D	HARTIG	B	HELDT	C
GORDO	B	GRIGSTON	B	HALGAITOH	B	HARTLAND	B	HELEMANO	C
GORDON	D	GRIMSTAD	B	HALII	B	HARTLETON	B	HELENA	C
GORE	D	GRISWOLD	B	HALIIMAILE	B	MARTLINE	B	HELMER	C
GORGONIO	A	GRITNEY	C	HALIS	B	HARTSBURG	B	HELVETIA	C
GORHAM	B	GRIVER	C	HALOL	B	HARTSELLS	B	HELY	B
GORIN	C	GRIZZLY	C	HALLECK	B	HARTSHORN	B	HEMBRE	B
GORING	C	GROGAN	B	HALL RANCH	C	HARVARD	B	HEMMI	C
GORMAN	B	GROSECLOSE	C	HALLVILLE	B	HARVEL	B	HEMPFIELD	
GORUS	A	GROSS	C	HALSEY	D	HARVEY	C	HEMPSTEAD	C
GORZELL	B	GROTON	A	HAMACER	A	HARWOOD	C	HENCRATT	B
GOSHEN	B	GROVE	A	HAMAKUAPOKO	B	HASKI	B	HENDERSON	B
GOSHUTE	D	GROVELAND	B	HAMAN	B	HASKILL	A	HENDRICKS	B
GOSPORT	C	GROVER	B	HAMAR	B	HASKINS	C	HENEFER	C
GOTHAM	A	GROVETON	B	HAMBLEN	C	HASSELL	C	HENKIN	B
HENLEY	C	HOBOG	D	HORD	B	HYAT	A	IZAGORA	C
HENLINE	C	HOBSON	C	HOREB	B	HYATTVILLE	C	IZEE	C
HENNEKE	D	HOCHEIM	B	HORNE	D	HYDABURG	D		
HENNEPIN	B	HOCKING	B	HORNELL	D	HYDE	D	JABU	C
HENNINGSEN	C	HOCKINSON	C	HORNING	A	HYDRO	C	JACAGUAS	B
HENRY	D	HOCKLEY	C	HRONITOS	D	HYMAS	D	JACANA	D
HENSEL	B	HODGE	B	HORROCKS	B	HYRUM	B	JACINTO	B
HENSHAW	C	HODGINS	C	HORSESHOE	B	HYSHAM	D	JACK CREEK	A
HENSLEY	D	HODGSON	C	HORTON	B			JACKLIN	B
HEPLER	D	HOEBE	B	HORTONVILLE	B	IAO	C	JACKNIFE	C
HERBERT	B	HOELZLE	C	HOSKIN	C	IBERIA	D	JACKPORT	D
HEREFORD	B	HOFFMAN	C	HOSKINNINI	D	ICENE	C	JACKS	C
HERKIMER	B	HOFFMANVILLE	C	HOSLEY	D	IDA	B	JACKSON	B
HERLONG	D	HOGANSBURG	B	HOSMER	C	IDABEL	B	JACKSONVILLE	C
HERMISTON	B	HOGELAND	B	HOTAW	C	IDAK	B	JACOB	D
HERMON	A	HOGG	C	HOT LAKE	C	IDANA	C	JACOBSEN	D
HERNDON	B	HOGRIS	B	HOUDEK	B	IDEON	D	JACOBY	C
HERO	B	HOH	B	HOUGHTON	A/D	IDMON	B	JACQUES	C
HERRERA	A	HOHMANN	C	HOUK	C	IGNACIO	C	JACQUITH	C

HERRICK	C	HOKO	C	HOULKA	D	IGO	D	JACWIN	B
HERRON	B	HOLBROOK	B	HOULTON	C/D	IGUALDAD	D	JAFFREY	A
HERSH	A	HOLCOMB	D	HOUNDBY	D	IHLEN	D	JAGUEYES	B
HERSHAL	B/D	HOLDAWAY	D	HOURGLASS	B	IJAM	D	JAL	B
HESCH	B	HOLDEN	A	HOUSATONIC	D	ILDEFONSO	B	JALMAR	A
HESPER	C	HOLDER	B	HOUSEMOUNTAIN	D	ILKA	B	JAMES CANYON	B/C
HESPERIA	B	HOLDERMAN	C	HOUSEVILLE	C	ILLION	B/D	JAMESTOWN	C
HESPERUS	B	HOLDERNESS	C	HOUSTON	D	IMA	B	JANE	C
HESSE	C	HOLDREGE	B	HOUSTON BLACK	D	IMBLER	B	JANISE	C
HESSEL	D	HOLLAND	B	HOYDE	A/C	IMLAY	C	JANSEN	A
HESSELBERG	D	HOLLINGER	B	HOVEN	D	IMMOKALEE	B/D	JARAB	D
HESSELTINE	B	HOLLIS	C/D	HOVENWEEP	C	IMPERIAL	D	JARBOE	C
HESSLAN	C	HOLLISTER	D	HOVERT	D	INAVALE	A	JARITA	C
HESSON	C	HOLLOMAN	C	HOVEY	C	INDART	B	JARRE	B
HETTINGER	D	HOLLOWAY	A	HOWARD	B	INDIAHOMA	D	JARVIS	B
HEXT	B	HOLLY	D	HOWELL	C	INDIAN		JASPER	B
HEZEL	B	HOLLY SPRINGS	D	HOWLAND	C	INDIAN CREEK	D	JAUCAS	A
HIALEAH	D	HOLLYWOOD	D	HOYE	B	INDIANO	C	JAVA	B
HIAWATHA	A	HOLMDEL	C	HOYLETON	C	INDIANOLA	A	JAY	C
HIBBARD	D	HOLMES	B	HOYPUS	A	INDIO	B	JAYEM	B
HIBBING	C	HOLOMUA	B	HOYTVILLE	D	INGA	B	JAYSON	D
HIBERNIA	C	HOLOPAW	B/D	HUBBARD	A	INGALLS	B	JEAN	A
HICKORY	C	HOLROYD	B	HUBERLY	D	INGARD	B	JEANERETTE	D
HICKS	B	HOLSINE	B	HUBERT	B	INGENIO	C	JEAN LAKE	B
HIDALGO	B	HOLST	B	HUBLERSBURG	C	INGRAM	D	JEDD	C
HIDEAWAY	D	HOLSTON	B	HUCKLEBERRY	C	INKLER	B	JEDDO	D
HIDEWOOD	C	HOLT	B	HUDSON	C	INKS	D	JEFFERSON	B
HIERRO	C	HOLTLE	B	HUECO	C	INMACHUK	D	JEKLEY	C
HIGHAMS	D	HOLTVILLE	C	HUEL	A	INMAN	C	JELM	D
HIGHFIELD	B	HOLYOKE	C/D	HUENEME	B/C	INMO	A	JENA	B
HIGH GAP	C	HOMA	C	HUERHUERO	D	INNESVALE	D	JENKINS	B
HIGHLAND	B	HOME CAMP	C	HUEY	D	INSKIP	C	JENKINSON	D
HIGHMORE	B	HOMELAKE	B	HUFFINE	A	INVERNESS	D	JENNESS	B
HIGH PARK	B	HOMER	C	HUGGINS	C	INVILLE	B	JENNINGS	C
HIHIMANU	A	HOMESTAKE	D	HUGHES	B	INWOOD	C	JENNY	D
HIIBNER	C	HOMESTEAD	B	HUGHESVILLE	B	IO	B	JERAULD	D
HIKO PEAK	B	HONAUNAU	C	HUGO	B	IOLA	A	JERICHO	C
HIKO SPRINGS	D	HONCUT	B	HUICHICA	C/D	IOLEAU	C	JEROME	C

HILDRETH	D	HONDALE	D	HUIKAU	A	IONA	B	JERRY	C
HILEA	D	HONDO	C	HULETT	B	IONIA	B	JESBEL	D
HILES	B	HONDOHO	B	HULLS	C	IOSCO	B	JESSE CAMP	C
HILGER	B	HONEOYE	B	HULLT	B	IPAVA	B	JESSUP	C
HILGRAVE	B	HONEY	D	HULUA	D	IRA	C	JETT	B
HILLEMANN	C	HONEYGROVE	C	HUM	B	IREDELL	D	JIGGS	C
HILLERY	D	HONEYVILLE	C	HUMACAO	B	IRETEBA	C	JIM	C
HILLET	D	HONN	B	HUMATAS	C	IRIM	C	JIMENEZ	C
HILLFIELD	B	HONOKAA	A	HUMBARGER	B	IROCK	B	JIMTOWN	C
HILLGATE	D	HONOLUA	B	HUMBIRD	C	IRON BLOSSOM	D	JOB	C
HILLIARD	B	HONOMANU	B	HUMBOLDT	D	IRION MOUNTAIN	D	JOBOS	C
HILLON	B	HONOULIULI	D	HUMDUN	B	IRON RIVER	B	JOCITY	B
HILLSBORO	B	HONUAULU	A	HUME	C	IRONTON	C	JOCKO	A
HILLSDALE	B	HOOD	B	HUMESTON	C	IRRIGFON	C	JODERO	B
HILMAR	C/D	HOODLE	B	HUMMINGTON	C	IRVINGTON	C	JOEL	B
HILO	A	HOODSPORT	C	HUMPHREYS	B	IRWIN	D	JOES	B
HILT	B	HOODVIEW	B	HUMPTULIPS	B	ISAAC	C	JOHNS	C
HILTON	B	HOOKTON	C	HUNSAKER	B/C	ISAAQUAH	B/C	JOHNSBURG	D
HINCKLEY	A	HOOLEHUA	B	HUNTERS	B	ISAN	D	JOHNSON	B
HINDES	C	HOOPAL	D	HUNTING	C	ISANTI	D	JOHNSTON	B/D
HINESBURG	C	HOOPER	D	HUNTINGTON	B	ISBELL	C	JOHNSWOOD	B
HINKLE	D	HOOPESTON	B	HUNTSVILLE	B	ISHAM	C	JOICE	D
HINMAN	C	HOOSIC	A	HUPP	B	ISHI PISHI	C	JOLAN	C
HINSDALE		HOOT	D	HURDS	B	ISLAND	B	JOLIET	C
HINTZE	D	HOOTEN	D	HURLEY	D	ISOM	B	JONESVILLE	A
HIPPLE	C	HOOVER	B	HURON	C	ISSAQUAH	B/C	JONUS	B
HISLE	D	HOPEKA	D	HURST	D	ISTOKPOGA	D	JOPLIN	B
HITT	B	HOPETON	C	HURWAL	B	ITCA	D	JOPPA	B
HI VISTA	C	HOPEWELL		HUSE	C			JORDAN	D
HIWASSEE	B	HOPGOOD	C	HUSSA	B/D	IUKA	C	JORGE	B
HIWOOD	A	HOPKINS	B	HUSSMAN	D	IVA	C	JORNADA	C
HIXTON	B	HOPLEY	B	HUTCHINSON	C	IVAN	B	JORY	C
HOBACKER	B	HOPPER	B	HUTSON	B	IVES	B	JOSE	C
HOBAN	C	HOQUIAM	B	HUXLEY	D	IVIE	A	JOSEPHINE	B
HOBBS	B	HORATIO	D	HYAM	D	IVINS	C	JOSIE	B
JOY	B	KARNAK	D	KEOWNS	D	KIPP	C	KOVICH	D
JUANA DIAZ	B	KARNES	B	KEPLER	C	KIPPEN	A	KOYEN	B
JUBILEE	C	KARRO	B	KERBY	B	KIPSON	C	KOYUKUK	B

JUDD	D	KARS	A	KERMEL	B	KIRK	B/D	KRADE	B
JUDITH	B	KARSHNER	D	KERMIT	A	KIRKHAM	C	KRANZBURG	B
JUDKINS	C	KARTA	C	KERMO	A	KIRKLAND	D	KRATKA	C
JUDSON	B	KARTAR	B	KERR	B	KIRKTON	B	KRAUSE	A
JUDY	C	KASCHMIT	D	KERRICK	B	KIRKVILLE	C	KREAMER	C
JUGET	D	KASHWITNA	B	KERRTOWN		KIRTLEY	C	KREMLIN	B
JUGHANDLE	B	KASILOF	A	KERSHAW	A	KIRVIN	C	KRENTZ	C
JULES	B	KASKI	B	KERSICK	D	KISRING	D	KRESSON	C
JULESBURG	A	KASOTA	C	KERSTON	A/D	KISSICK	D	KRUM	D
JULIAETTA	B	KASSLER	A	KERT	C	KISTLER	C/D	KRUSE	B
JUMPE	B	KASSON	C	KERWIN	C	KITCHELL	B	KRUZOF	B
JUNCAL	C	KATAMA	B	KESSLER	C	KITCHEN CREEK	B	KUBE	B
JUNCOS	D	KATEMCY	C	KESWICK	D	KITSAP	C	KUBLER	C
JUNCTION	B	KATO	C	KETCHLY	B	KITTANNING		KUBLI	C
JUNEAU	B	KATRINE	B	KETTLE	B	KITTITAS	D	KUCERA	B
JUNIATA		KATULA	B	KETTLEMAN	B	KITTREDGE	C	KUCK	C
JUNIPERO	B	KATY	C	KETTNER	C	KITTSON	C	KUGRUG	D
JUNIUS	C	KAUFMAN	D	KEVIN	C	KIUP	B	KUHL	D
JUNO	B	KAUPO	A	KEWAUNEE	C	KIVA	B	KUKAIAU	A
JUNQUITOS	C	KAVETT	D	KEWEENAW	A	KIWANIS	A	KULA	B
JURA	C	KAWAIHAE	C	KEYA	B	KIZHUYAK	B	KULAKALA	B/C
JUVA	B	KAWAIHAPAI	B	KEYES	D	KJAR	D	KULLIT	B
JUVAN	D	KAWBAWGAM	C	KEYNER	D	KLABER	C	KUMA	B
		KAWICH	A	KEYPORT	C	KLAMATH	B/D	KUNIA	B
KAALUALU	A	KAWKAWLIN	C	KEYSTONE	A	KLAUS	A	KUNUWETA	C
KACHEMAK	B	KEAAU	D	KEYTESVILLE	D	KLAWASI	D	KUPREANOF	B
KADAKE	D	KEAHUA	B	KEZAR	B	KLEJ	B	KUREB	A
KADASHAN	B	KEALAKEKUA	C	KIAWAH	C	KLICKER	C	KURO	D
KADE	C	KEALIA	D	KIBBIE	B	KLICKITAT	C	KUSKOKWIM	D
KADIN	B	KEANSBURG	D	KICKERVILLE	B	KLINE	B	KUSLINA	D
KADOKA	B	KEARNS	B	KIDD	D	KLINESVILLE	C/D	KUTCH	D
KAENA	D	KEATING	C	KIDMAN	B	KLINGER	B	KUTZTOWN	B
KAHALUU	D	KEAUKAHA	D	KIEHL	A	KLONKIKE	D	KVICHAK	B
KAHANA	B	KEAWAKAPU	B	KIETZKE	D	KLONE	B	KWETHLUK	A
KAHANUI	B	KEBLER	B	KIEV	B	KLOOCHMAN	C	KYLE	D
KAHLER	B	KECH	D	KIKONI	B	KLOTEN	B	KYLER	D
KAHOLA	B	KECKO	B	KILARC	D	KLUTINA	B		
KAH SHEETS	D	KEDRON	C	KILAUEA	B	KNAPPA	B	LA BARGE	B

KAHUA	D
KAIKLI	D
KAILUA	A
KAIMU	A
KAINALIU	A
KAIPOIOI	B
KAIWIKI	A
KALAE	B
KALALOCH	B
KALAMA	C
KALAMAZOO	B
KALAPA	B
KALAUPAPA	D
KALIFONSKY	D
KALIHI	D
KALISPELL	A
KALKASKA	A
KALMIA	B
KALOKO	D
KALOLOCH	B
KALSIN	D
KAMACK	B
KAMAKOA	A
KAMAOA	B
KAMAOLE	B
KAMAY	D
KAMIE	B
KAMRAR	B
KANABEC	B
KANAKA	B
KANAPAHA	A/D
KANDIK	B
KANE	B
KANEOHE	B
KANEPUU	B
KANIMA	C
KANLEE	B
KANOSH	C
KEEFERS	C
KEEGAN	
KEEI	D
KEFKEE	B
KEELDAR	B
KEENE	C
KEENO	C
KEESE	D
KEG	B
KEHENA	C
KEIGLEY	C
KEISER	B
KEITH	B
KEKAHA	B
KEKAKE	D
KELLER	C
KELLY	D
KELN	C
KELSEY	D
KELSO	C
KELTNER	B
KELVIN	C
KEMMERER	C
KEMOO	B
KEMPSVILLE	B
KEMPTON	B
KENAI	C
KENANSVILLE	A
KENDAIA	C
KENDALL	B
KENDALLVILLE	B
KENESAW	B
KENMOOR	B
KENNALLY	B
KENNAN	B
KENNEBEC	B
KENNEDY	B/C
KENNER	D
KILBOURNE	A
KILBURN	B
KILCHIS	D
KILDOR	C
KILGORE	B/D
KILKENNY	B
KILLBUCK	C/D
KILLEY	D
KILLINGWORTH	
KILLPACK	C
KILMERQUE	C
KILN	D
KILOA	A
KILOHANA	A
KILWINNING	C
KIM	B
KIMANA	B
KIMBALL	C
KIMBERLY	B
KIMBROUGH	D
KIMMERLING	D
KIMMONS	C
KIMO	C
KINA	D
KINCO	A
KINESAVE	C
KINGFISHER	B
KINGHURST	B
KINGMAN	D
KINGS	C/D
KINGSBURY	D
KINGSLEY	B
KINGS RIVER	C
KINGSTON	B
KINGSVILLE	C
KINKEAD	C
KINKEL	B
KINKORA	D
KNEELAND	C
KNIFFIN	C
KNIGHT	C
KNIK	B
KNIPPA	D
KNOB HILL	B
KNOWLES	B
KNOX	B
KNULL	C
KNUTSEN	B
KOBAR	C
KOBEH	B
KOCH	C
KODAK	C
KODIAK	B
KOEHLER	C
KOELE	B
KOEPKE	B
KOERLING	B
KOGISH	D
KOHALA	A
KOKEE	B
KOKERNOT	C
KOKO	B
KOKOKAHI	D
KOKOMO	B/D
KOLBERG	B
KOLEKOLE	C
KOLLS	D
KOLLUTUK	D
KOLOA	C
KOLOB	C
KOLOKOLO	B
KONA	D
KONAWA	B
KONNER	D
KONOKTI	C
KOOLAU	C
LABETTE	C
LABISH	D
LABOU	D
LABOUNTY	C
LA BOUNTY	C
LA BRIER	C
LABSHAFT	D
LACAMAS	C/D
LA CASA	C
LACITA	B
LACKAWANNA	C
LACONA	C
LACOTA	D
LACY	D
LADD	B
LADDER	D
LADELLE	B
LADOGA	C
LADUE	B
LADYSMITH	D
LA FARGE	B
LAFE	D
LAFITE	D
LA FONDA	B
LAFONT	B
LAGLORIA	B
LAGONDA	C
LA GRANDE	C
LAGRANGE	D
LAHAINA	B
LA HOGUE	B
LAHONTAN	D
LAHRITY	A
LAIDIG	C
LAIDLAW	B
LAIL	C
LAIRDSVILLE	D
LAIREP	D

KANZA	D
KAPAA	A
KAPAPALA	B
KAPOD	B
KAPOWSIN	C
KAPUHIKANI	D
KARAMIN	B
KARDE	B
KARHEEN	D
KARLAN	C
KARLIN	A
KARLO	D
KARLUK	D
LAKEVIEW	C
LAKEWIN	B
LAKEWOOD	A
LAKI	B
LAKIN	A
LAKOMA	D
LALAAU	A
LA LANDE	B
LALLIE	D
LAM	B/D
LAMAR	B
LAMARTINE	B
LAMBERT	B
LAMBETH	C
LAMBORN	D
LAMINGTON	D
LAMO	B
LAMONI	D
LAMONT	A
LAMONTA	D
LAMOURE	C
LAMPHIER	B
LAMPSHIRE	D
LAMSON	D
LANARK	B
KENNEWICK	B
KENNEY	A
KENNEY LAKE	C
KENO	D
KENOMA	D
KENSAL	B
KENSPUR	A
KENT	D
KENYON	C
KEO	B
KEOLDAR	B
KEOMAH	C
KEOTA	C
LATAH	C
LATAHCO	C
LATANG	B
LATANIER	D
LATENE	B
LATHAM	D
LATHROP	C
LATINA	D
LATOM	D
LATONIA	B
LATTY	D
LAUDERDALE	B
LAUGENOUR	B/D
LAUGHLIN	B
LAUMAIA	B
LAUREL	C
LAURELHURST	C
LAURELWOOD	B
LAUREN	B
LAVALEE	B
LAVATE	B
LAVEEN	B
LAVELDO	D
LAVERKIN	C
LA VERKIN	C
KINMAN	C
KINNEAR	B
KINNEY	B
KINNICK	C
KINREAD	D
KINROSS	D
KINSTON	D
KINTA	D
KINTON	C
KINZEL	B
KIOMATIA	A
KIONA	B
KIPLING	D
LENAWEE	B/D
LENNEP	D
LENOIR	D
LENOX	B
LENZ	B
LEO	B
LEON	A/D
LEONARD	C
LEONARDO	B
LEONARDTOWN	D
LEONIDAS	B
LEOTA	C
LEPLEY	D
LERDAL	C
LEROY	B
LESAGE	B
LESHARA	B
LESHO	C
LESLIE	D
LESTER	B
LE SUEUR	B
LETA	C
LETCHER	D
LETHA	D
LETHENT	C
KOOSKIA	C
KOOTENAI	A
KOPIAH	D
KOPP	B
KOPPES	B
KORCHEA	B
KORNMAN	B
KOSMOS	D
KOSSE	D
KOSTER	C
KOSZTA	B
KOTEDO	D
KOUTS	B
LINVILLE	B
LINWOOD	A/D
LIPAN	D
LIPPINCOTT	B/D
LIRIOS	B
LIRRET	D
LISADE	B
LISAM	D
LISBON	B
LISMAS	D
LISMORE	B
LITCHFIELD	A
LITHGOW	C
LITHIA	C
LITIMBER	C
LITLE	C
LITTLEBEAR	A
LITTLEFIELD	D
LITTLE HORN	C
LITTLE POLE	D
LITTLETON	B
LITTLE WOOD	B
LITZ	C
LIV	C
LIVERHORE	A
LAJARA	D
LAKE	A
LAKE CHARLES	D
LAKE CREEK	C
LAKEHELEN	B
LAKEHURST	A
LAKE JANEE	B
LAKELAND	A
LAKEMONT	D
LAKEPORT	B
LAKESHORE	D
LAKESOL	B
LAKETON	B
LORADALE	C
LORAIN	C/D
LORDSTOWN	C
LOREAUVILLE	C
LORELLA	D
LORENZO	A
LORETTO	B
LORING	C
LOS ALAMOS	B
LOS BANOS	C
LOSEE	B
LOS GATOS	B/C
LOS GUINEOS	C
LOSHMAN	D
LOS OSOS	C
LOS ROBLES	B
LOS TANOS	B
LOST CREEK	B
LOST HILLS	C
LOS TRANCOS	D
LOSTWELLS	B
LOTHAIR	C
LOTUS	B
LOUDON	C
LOUDONVILLE	C

LANCASTER	B	LAVINA	C	LETORT	B	LIVIA	D	LOUIE	C
LANCE	C	LAWAI	B	LETTERBOX	B	LIVINGSTON	D	LOUISA	B
LAND	D	LAWET	C	LEVAN	A	LIVONA	A	LOUISBURG	B
LANDES	B	LAWLER	B	LEVASY	C	LIZE	C	LOUP	D
LANDISBURG	C	LAWRENCE	C	LEVERETT	C	LIZZANT	B	LOURDES	C
LANDLOW	C	LAWRENCEVILLE	C	LEVIATHAN	B	LLANOS	C	LOUVIERS	D
LANDOUSKY	D	LAWSHE	C	LEVIS	C	LOBDELL	C	LOVEJOY	C
LANE	C	LAWSON	B	LEWIS	D	LOBELVILLE	C	LOVELAND	C
LANEY	C	LAWTHER	D	LEWISBERRY	B	LOBERG	B	LOVELL	C
LANG	B/D	LAWTON	C	LEWISBURG	C	LOBERT	B	LOVELOCK	C/D
LANGFORD	C	LAX	C	LEWISTON	C	LOBITOS	C	LOWELL	C
LANGHEI	B	LAXAL	B	LEWISVILLE	C	LOCANE	D	LOWRY	B
LANGLEY	C	LAYCOCK	B	LEX	B	LOCEY	C	LOWVILLE	B
LANGLOIS	D	LAYTON	A	LEXINGTON	B	LOCHSA	B	LOYAL	B
LANGOLA	B	LAZEAR	D	LHAZ	B	LOCKE	B	LOYALTON	D
LANGRELL	B	LEA	C	LIBBINGS	D	LOCKERBY	C	LOYSVILLE	D
LANGSTON	C	LEADER	B	LIBBY	B	LOCKHARD	B	LOZANO	B
LANIER	B	LEADPOINT	B	LIBEG	A	LOCKHART	B	LOZIER	D
LANIGER	B	LEADVALE	C	LIBERAL	D	LOCKPORT	D	LUALUALEI	D
LANKBUSH	B	LEADVILLE	B	LIBERTY	C	LOCKWOOD	B	LUBBOCK	C
LANKIN	C	LEAF	D	LIBORY	A	LOCUST	C	LUBRECHT	C
LANKTREE	C	LEAHY	C	LIBRARY	D	LODAR	D	LUCAS	C
LANOAK	B	LEAL	B	LIBUTTE	D	LODEMA	A	LUCE	C
LANSDALE	B	LEAPS	C	LICK	B	LODI	C	LUCEDALE	B
LANSDOWNE	C	LEATHAM	C	LICK CREEK	D	LODO	D	LUCERNE	B
LANSING	B	LEAVENWORTH	B	LICKDALE	D	LOFFTUS	C	LUCIEN	C
LANTIS	B	LEAVITT	B	LICKING	C	LOFTON	D	LUCILE	D
LANTON	D	LEAVITTVILLE	B	LICKSKILLET	D	LOGAN	D	LUCILETON	B
LANTONIA	B	LEBANON	C	LIDDELL	D	LOGDELL	D	LUCKENBACH	C
LANTZ	D	LEBAR	B	LIEBERMAN	C	LOGGERT	A	LUCKY	B
LAP	D	LE BAR	B	LIEN	D	LOGHOUSE	B	LUCKY STAR	B
LA PALMA	C	LEBEC	B	LIGGET	B	LOGY	B	LUCY	A
LAPEER	B	LEBO	C	LIGHTNING	D	LOHLER	C	LUDDEN	D
LAPINE	A	LEBSACK	C	LIGNUM	C	LOHMILLER	C	LUDLOW	C
LAPLATTA	C	LECK KILL	B	LIGON	D	LOHNES	A	LUEDERS	C
LAPON	D	LEDBEDER	B	LIHEN	A	LOIRE	B	LUFKIN	D
LAPORTE	C	LEDGEFORK	A	LIHUE	B	LOLAK	D	LUHON	B
LA POSTA	A	LEDGER	D	LIKES	A	LOLALITA	B	LUJANE	C

LA PRAIRIE	B	LEDRU	D	LILAH	A	LOLEKAA	B	LUKIN	C
LARABEE	B	LEDY		LILLIWAUP	A	LOLETA	C/D	LULA	B
LARAND	B	LEE	D	LIMA	B	LOLO	A	LULING	D
LARCHMOUNT	B	LEEDS	C	LIMANI	B	LOLON	A	LUMBEE	D
LARDELL	C	LEEFIELD	C	LIMBER	B	LOMA	C	LUMMI	B/C
LAREDO	B	LEELANAU	A	LIMERICK	C	LOMALTA	D	LUN	C
LARES	C	LEEPER	D	LIMON	C	LOMAX	B	LUNA	C
LARGENT	D	LEESVILLE	B/C	LIMONES	B	LOMIRA	B	LUNCH	C
LARGO	B	LEETON	C	LIMPIA	C	LOMITAS	D	LUNDIMO	C
LARIM	A	LEETONIA	C	LINCO	B	LONDO	C	LUNDY	D
LARIMER	B	LEFOR	B	LINCOLN	A	LONE	C	LUNT	C
LARKIN	B	LEGLER	B	LINCROFT	A	LONE PINE	C	LUPPINO	C
LARKSON	C	LEGORE	B	LINDLEY	C	LONE RIDGE	B	LUPTON	D
LA ROSE	B	LEHEW	C	LINDSEY	D	LONE ROCK	A	LURA	D
LARRY	D	LEHIGH	C	LINDSIDE	C	LONETREE	A	LURAY	C/D
LARSON	D	LEHMANS	D	LINDSTROM	B	LONGFORD	C	LUTE	D
LARUE	A	LEHR	B	LINDY	C	LONGLOIS	B	LUTH	C
LARVIE	D	LEICESTER	C	LINEVILLE	C	LONGMARE	D	LUTHER	B
LAS	C	LEILEHUA	B	LINGANORE	B	LONGMONT	C	LUTIE	B
LAS ANIMAS	C	LELA	D	LINKER	B	LONGRIE	C	LUTON	D
LASAUSES	C	LELAND	D	LINKVILLE	B	LONGVAL	B	LUVERNE	C
LAS FLORES	D	LEMETA	D	LINNE	C	LONG VALLEY	B	LUXOR	D
LASHLEY		LEMING	C	LINNET	D	LONGVIEW	C	LUZEMA	D
LASIL	D	LEMM	B	LINNEUS	B	LONOKE	B	LYCAN	B
LAS LUCAS	C	LEMONEX	D	LINO	C	LONTI	C	LYCOMING	C
LAS POSAS	C	LEMPSTER	C/D	LINOYER	B	LOOKOUT	C	LYDA	D
LASSEN	D	LEN	C	LINSLAW	D	LOON	B	LYDICK	B
LASTANCE	B	LENA	A	LINT	B	LOPER	B	LYFORD	C
LAS VEGAS	D	LENAPAH	D	LINTON	B	LOPEZ	D	LYLES	B
LYMAN	C/D	MALIN	C/D	MARLETTE	B	MAY DAY	D	MCPHERSON	C
LYMANSON	C	MALJAMAR	B	MARLEY	C	MAYER	D	MCPHIE	B
LYNCH	D	MALLOT	A	MARLIN	D	MAYES	D	MCQUARRIE	D
LYNCHBURG	B/D	MALM	C	MARLOW	C	MAYFIELD	B	MCQUEEN	C
LYNDEN	A	MALO	B	MARLTON	C	MAYFLOWER	C	MCRAE	B
LYNNDYL	A	MALONE	B	MARMARTH	B	MAYHEW	D	MCTAGGART	B
LYNN HAVEN	B/D	MALOTERRE	D	MARNA	D	MAYLAND	C	MCVICKERS	C
LYNNVILLE	C	MALPAIS	C	MARPA	B	MAYMEN	D	MEAD	D
LYNX	B	MALPOSA	C	MARPLEEN	D	MAYNARD LAKE	B	MEADIN	A

LYONMAN	C	MALVERN	C	MARQUETTE	A	MAYO	B	MEADOWVILLE	B
LYONS	D	MAMALA	D	MARR	B	MAYODAN	B	MEADVILLE	C
LYONSVILLE	B	MAMOU	C	MARRIOTT	B	MAYOWORTH	C	MEANDER	D
LYSINE	D	MANAHAA	C	MARSDEN	C	MAYSDORF	B	MECAN	B
LYSTAIR	B	MANALAPAN		MARSELL	B	MAYSVILLE		MECCA	B
LYTELL	B	MANANA	C	MARSHALL	B	MAYRTOWN	C	MECKESVILLE	C
		MANASSA	C	MARSHAN	D	MAYVILLE	B	MECKLENBURG	C
MABANK	D	MANASSAS	B	MARSHDALE	C	MAYWOOD	B	MEDA	B
MABEN	C	MANASTASH	C	MARSHFIELD	C	MAZEPPA	B	MEDANO	C
MABI	D	MANATEE	B/D	MARSING	B	MAZON	C	MEDARY	C
MABRAY	D	MANAWA	C	MART	C	MAZUMA	C	MEDFORD	B
MACAR	B	MANCELONA	A	MARTELLA	B	MCAFE	C	MEDFRA	D
MACEDONIA	C	MANCHESTER	A	MARTIN	C	MCALLEN	B	MEDICINE LODGE	B
MACFARLANE	B	MANDAN	B	MARTINA	A	MCALLISTER	C	MEDINA	B
MACHETE	C	MANDERFIELD	B	MARTINECK	D	MCALPIN	C	MEDLEY	B
MACHIAS	B	MANDEVILLE	B	MARTINEZ	D	MCBEE	B	MEDWAY	B
MACHUELO	D	MANFRED	D	MARTINI	B	MCBETH	D	MEEKS	A
MACK	C	MANGUM	D	MARTINSBURG	B	MCBRIDE	B	MEETEETSE	D
MACKEN	D	MANHATTAN	A	MARTINSDALE	B	MCCABE	B	MEGGETT	D
MACKINAC	B	MANHEIM	C	MARTINSON	D	MCCAFFERY	A	MEGON	C
MACKSBURG	B	MANI	C	MARTINSVILLE	B	MCCAIN	C	MEHL	C
MACOMB	B	MANILA	C	MARTINTON	C	MCCALEB	B	MEHLHORN	C
MACOMBER	B	MANISTEE	B	MARTY	B	MCCALLY	D	MEIGS	
MACON	B	MANITOU	C	MARVAN	D	MCCAMMON	D	MEIKLE	D
MACY	B	MANLEY	B	MARVELL	B	MCCANN	C	MEISS	D
MADALIN	D	MANLIUS	C	MARVIN	C	MCCARRAN	D	MELBOURNE	B
MADAWASKA	B	MANLOVE	B	MARY	C	MCCARTHY	B	MELBY	C
MADDOCK	A	MANNING	B	MARYDEL	B	MCCLAVE	C	MELITA	B
MADDOX		MANOGUE	D	MARYSLAND	D	MCCLEARY	C	MELLENTHIN	D
MADELIA	C	MANOR	B	MASADA	C	MCCLELLAN	B	MELLOR	D
MADELINE	D	MANSFIELD	D	MASCAMP	D	MCCLOUD	C	MELLOTT	B
MADERA	D	MANSIC	B	MASCHETAH	B	MCCOIN	D	MELOLAND	C
MADISON	B	MANSKER	B	MASCOTTE	D	MCCOLL	D	MELROSE	C
MADONNA	C	MANTACHIE	C	MASHEL	C	MCCONNEL	B	MELSTONE	A
MADRAS	C	MANTEO	C/D	MASHULAVILLE	B/D	MCCOOK	B	MELTON	B
MADRID	B	MANTER	B	MASON	B	MCCORNICK	C	MELVILLE	B
MADRONE	C	MANTON	B	MASONVILLE	C	MCCOY	C	MELVIN	D
MADUREZ	B	MANTZ	B	MASSACK	B	MCCREE	B	MEMALOOSE	D

MAFURT	B	MANU	C	MASSENA	C	MCCRORY	D	MEMPHIS	B
MAGALLON	B	MANVEL	C	MASSILLON	B	MCCROSKIE	D	MENAHGA	A
MAGENS	B	MANWOOD	D	MASTERSON	B	MCCULLOUGH	C	MENAN	C
MAGGIE	D	MANZANITA	C	MATAGORDA	D	MCCULLY	C	MENARD	B
MAGINNIS	C	MANZANO	C	MATAMOROS	C	MCCUNE	D	MENCH	C
MAGNA	D	MANZANOLA	C	MATANUSKA	C	MCCUTCHEN	C	MENDEBOURE	C
MAGNOLIA	B	MAPES	C	MATANZAS	B	MCDOLE	B	MENDOCINO	B
MAGNUS	C	MAPLE MOUNTAIN	B	MATAPEAKE	B	MCDONALD	B	MENDON	B
MAGOTSU	D	MAPLETON	C/D	MATAWAN	C	MCDONALDSVILLE	C	MENDOTA	B
MAGUAYO	D	MARAGUEZ	B	MATCHER	A	MCEWEN	B	MENEFEE	D
MAHAFFEY	C/D	MARATHON	B	MATFIELD	C	MCFADDEN	B	MENFRO	B
		MARBLE	A	MATHERS	B				
MAHALA	C	MARBLEMOUNT	B	MATHERTON	B	MCFAUL	C	MENO	C
MAHALASVILLE	B/D	MARCELINAS	D	MWATHESON	B	MCGAFFEY	B	MENOKEN	C
MAHANA	B	MARCETTA	A	MATHEWS		MCGARR	C	MENOMINEE	B
MAHASKA	B	MARCIAL	D	MATHIS	A	MCGARY	C	MENTO	C
MAHER	C	MARCUM	B	MATHISTON	C	MCGEHEE	C	MENTOR	B
MAHONING	D	MARCUS	C	MATLOCK	D	MCGILVERY	D	MEQUON	C
MAHUKONA	B	MARCUSE	D	MATMON	D	MCGINTY	B	MERCED	C/D
MAIDEN	B	MARCY	D	MATTAPEX	C	MCGIRK	C	MERCEDES	D
MAIEE	A	MARDEN	C	MATTOLE	C	MCGOWAN	B	MERCER	C
MAINSTAY	D	MARDIN	C	MAU	D	MCGRATH	B	MERCEY	C
MAJADA	B	MARENGO	C/D	MAUDE	B	MCGREW	A	MEREDITH	B
MAKAALAE	B	MARESUA	B	MAUGHAN	C	MCHENRY	B	MERETA	C
MAKALAPA	D	MARGERUM	B	MAUKEY	C	MCILWAINE	A	MERGEL	B
MAKAPILI	A	MARGUERITE	B	MAUMEE	A/D	MCINTOSH	B	MERIDIAN	B
MAKAWAO	B	MARIA	B/C	MAUNABO	D	MCINTYRE	B	MERINO	D
MAKAWELI	B	MARIANA	C	MAUPIN	C	MCKAMIE	D	MERKEL	B
MAKENA	B	MARIAS	D	MAUREPAS	D	MCKAY	D	MERLIN	D
MAKIKI	B	MARICAO	B	MAURICE	A	MCKENNA	C/D	MERMILL	B/D
MAKLAK	A	MARICOPA	B	MAURINE	D	MCKENZIE	D	MERNA	D
MAKOTI	C	MARIETTA	C	MAURY	B	MCKINLEY	B	MEROS	A
MAL	B	MARILLA	C	MAVERICK	C	MCKINNEY	D	MERRIFIELD	B
MALA	B	MARINA	A	MAVIE	D	MCLAIN	C	MERRILL	C
MALABAR	A/D	MARION	D	MAWAE	A	MCLAURIN	B	MERRILLAN	C
MALABON	C	MARIPOSA	C	MAX	B	MCLEAN	C	MERRIMAC	A
MALACHY	B	MARISSA	C	MAXEY	C	MCLEOD	B	MERRITT	B/C
MALAGA	B	MARKES	D	MAXFIELD	C	MCMAHON	C	MER ROUGE	B

MALAMA	A	MARKEY	D	MAXSON	A	MCMEEN	C	MERTON	B
MALAYA	D	MARKHAM	C	MAXTON	B	MCMULLIN	D	MERTZ	B
MALBIS	B	MARKLAND	C	MAXVILLE	A	MCMURDIE	C	MESA	B
MALCOLM	B	MARKSBORO	C	MAXWELL	D	MCMURPHY	B	MESCAL	B
MALETTI	C	MARLA	A	MAY	B	MCMURRAY	D	MESCALERO	C
MALEZA	B	MARLBORO	B	MAYBERRY	C	MCNARY	D	MESITA	C
MALIBU	D	MARLEAN	B	MAYBESO	D	MCPAUL	B	MESKILL	C
MESMAN	C	MINORA	C	MONTOYA	D	MURDOCK	C	NAVARRO	B
MESPUN	A	MINTO	C	MONTPIELLIER	C	MUREN	B	NAVESINK	
MESSER	C	MINU	D	MONTROSE	B	MURRILL	B	NAYLOR	
MET	D	MINVALE	B	MONTVALE	D	MURVILLE	D	MAYPED	C
METALINE	B	MIRA	D	MONTVERDE	A/D	MUSCATINE	B	NAZ	B
METAMORA	B	MIRABAL	C	MONTWEL	C	MUSE	C	N-BAR	B
METEA	B	MIRACLE	B	MONUE	B	MUSELLA	B	NEAPOLIS	B/D
METHOW	B	MIRAMAR	B	MOODY	B	MUSICK	B	NEBEKER	C
METIGOSHE	A	MIRANDA	D	MOOHOO	B	MUSINIA	B	NEBGEN	D
METOLIUS	B	MIRES	B	MOOSE RIVER	D	MUSKINGUM	C	NEBISH	B
METRE	D	MIRROR	B	MORA	B	MUSKOGEE	C	NEBO	
METZ	A	MIRROR LAKE	A	MORADO	C	MUSQUIZ	C	NECHE	C
MEXICO	D	MISSION	B	MORALES	D	MUSSEL	B	NEDERLAND	B
MHOON	D	MITCH	B	MORD	C	MUSSELSHELL	B	NEEDHAM	D
MIAMI	B	MITCHELL	B	MOREAU	D	MUSSEY	D	NEEDLE PEAK	C
MIAMIAN	C	MITIWANGA	C	MOREHEAD	C	MUSTANG	A/D	NEEDMORE	C
MICCO	A/D	MITRE	C	MOREHOUSE	C	MUTNALA	B	NEELEY	B
MICHELSON	B	MIZEL	D	MORELAND	D	MUTUAL	B	NEESOPAH	C
MICHIGAMME	C	MIZPAH	C	MORELANDTON	A	MYAKKA	A/D	NEGITA	B
MICK	B	MOANO	D	MORET	D	MYATT	B/D	NEGLEY	B
MIDAS	D	MOAPA	D	MOREY	D	MYERS	D	NEHALEM	B
MIDDLE	C	MOAULA	A	MORFITT	B	MYERSVILLE	B	NEHAR	B
MIDDLEBURY	B	MOBEETIE	B	MORGANFIELD	B	MYLREA	B	NEILTON	A
MIDESSA	B	MOCA	D	MORGNEC		MYRICK	D	NEISSON	B
MIDLAND	D	MOCHO	B	MORIARTY	D	MYRTLE	B	NEKIA	C
MIDNIGHT	D	MODA	D	MORICAL	C	MYSTEN	A	NELLIS	B
MIDVALE	C	MODALE	C	MORLEY	C	MYSTIC	D	NELMAN	B
MIDWAY	D	MODEL	C	MORMON MESA	D	MYTON	B	NELSCOTT	B
MIFFLIN	B	MODENA	B	MOROCCO	A/C			NELSON	B
MIFFLINBURG	B	MODESTO	C	MORONI	D	NAALEHU	B	NEMAH	C
MIGUEL	D	MODOC	C	MOROP	C	NEBESNA	D	NEMOTE	A

MIKE	D	MOENKOPIE	D	MORRILL	B	NACEVILLE	C	NENANA	B
MIKESELL	C	MOEPITZ	B	MORRIS	C	NACHES	B	NENNO	B
MILACA	B	MOFFAT	B	MORRISON	B	NACIMIENTO	C	NEOLA	D
MILAN	B	MOGOLLON	B	MORROW	C	NACOGDOCHES	B	NEOTOMA	B
MILES	B	MOGUL	B	MORSE	D	NADEAN	B	NEPALTO	A
MILFORD	C	MOHALL	B	MORTENSON	C	NADINA	D	NEPESTA	C
MILHAM	C	MOHAVE	B	MORTON	B	NAFF	B	NEPHI	B
MILHEIM	C	MOHAWK	B	MORVAL	B	NAGEESI	B	NEPPEL	B
MILL	B	MOIRA	C	MOSBY	C	NAGITSY	C	NEPTUNE	A
MILLARD	B	MOKELUMNE	D	MOSCA	A	NAGLE	B	NERESON	B
MILLBORO	D	MOKENA	C	MOSCOW	C	NAGOS	D	NESDA	A
MILLBROOK	B	MOKIAK	B	MOSEL	C	NAHATCHE	C	NESHAMINY	B
MILLBORNE	B	MOKULEIA	B	MOSHANNON	D	NAHMA	C	NESIKA	B
MILLCREEK	B	MOLAND	B	MOSHER	D	NAHUNTA	C	NESKAHI	B
MILLER	D	MOLCAL	B	MOSHERVILLE	C	NAIWA	B	NESKOWIN	C
MILLERLUX	D	MOLENA	A	MOSIDA	B	NAKAI	B	NESPELEM	B
MILLERTON	D	MOLINOS	B	MOSQUET	D	NAKNEK	D	NESS	D
MILLETT	B	MOLLVILLE	D	MOSSYROCK	B	NALDO	B	NESSEL	B
MILLGROVE	B/D	MOLLY	B	MOTA	B	NAMBE	B	NESSOPAH	B
MILL HOLLOW	B	MOLOKAI	B	MOTLEY	B	NAMON	C	NESTER	C
MILLICH	D	MOLSON	B	MOTOQUA	D	NANAMKIN	A	NESTUCCA	C
MILLIKEN	C	MOLYNEUX	B	MOTTSVILLE	A	NANCY	B	NETARTS	A
MILLINGTON	B	MONAD	A	MOULTON	B/D	NANNY	B	NETCONG	B
MILLIS	C	MONAHAN	D	MOUND	C	NANNYTON	B	NETO	B
MILLRACE	B	MONAHANS	B	MOUNTAINBURG	D	NANSENE	B	NETTLETON	C
MILLSAP	C	MONARDA	D	MOUNTAINVIEW	B/D	NANTUCKET	C	NEUBERT	B
MILLSDALE	B/D	MONCLOVA	B	MOUNTAINVILLE	B	NANUM	C	NEUNS	B
MILLSHOLM	C	MONDAMIN	C	MOUNT AIRY	A	NAPA	D	NEUSKE	B
MILLVILLE	B	MONDOVI	B	MOUNT CARROLL	B	NAPAISHAK	D	NEVADOR	C
MILLWOOD	D	MONEE	D	MOUNT HOME	B	NAPAVINE	B	NEVILLE	B
MILNER	C	MONICO	B	MOUNT HOOD	B	NAPIER	B	NEVIN	C
MILPITAS	C	MONIDA	B	MOUNT LUCAS	C	NAPLENE	B	NEVINE	B
MILROY	D	MONITEAU	D	MOUNT OLIVE	D	NAPLES	B	NEVKA	C
MILTON	C	MONMOUTH	C	MOUNTVIEW	B	NAPPANEE	D	NEVOYER	D
MIMBRES	C	MONO	D	MOVILLE	C	NAPTOWNE	B	NEVTAH	C
MIMOSA	C	MONOLITH	C	MOWATA	D	NARANJITO	C	NEVU	D
MINA	C	MONONA	B	MOWER	C	NARANJO	C	NEWARK	C
MINAM	B	MONONGAHELA	C	MOYERSON	D	NARCISSE	B	NEWART	B

MINATARE	D	MONROE	B	MOYINA	D	NARD	B	NEWAYGO	B
MINCHEY	B	MONROEVILLE	C/D	MUCARA	D	NARLON	C	NEWBERG	B
MINCO	B	MONSE	B	MUCET	C	NARON	B	NEWBERRY	C
MINDALE	B	MONSERATE	C	MUDRAY	D	NARRAGANSETT	B	NEWBY	B
MINDEGO	B	MONTAGUE	D	MUD SPRINGS	C	NARROWS	D	NEW CAMBRIA	C
MINDEMAN	B	MONTALTO	C	MUGHOUSE	C	NASER	B	NEWCASTLE	B
MINDEN	C	MONTARA	D	MUIR	B	NASH	B	NEWCOMB	A
MINE	B	MONTAUK	C	MUIRKIRK	B	NASHUA	A	NEWDALE	B
MINEOLA		MONTCALM	A	MUKILTEO	D	NASHVILLE	B	NEWELL	B
MINER	D	MONTE	B	MULDROW	D	NASON	C	NEWELLTON	D
MINERAL	A	MONTE CRISTO	D	MULKEY	C	NASSAU	C/D	NEWFANE	
MINERAL MO	C	MONTEGRANDE	D	MULLINS	D	NASSET	B	NEWFORK	D
MINERVA	B	MONTELL	D	MULLINVILLE	B	NATALIE	C	NEWKIRK	D
MING	B	MONTELLO	C	MULT	C	NATCHEZ	B	NEWLANDS	B
MINGO	B	MONTEOLA	D	MULTORPOR	A	NATHROP	B	NEWLIN	B
MINIDOKA	C	MONTEROSA	D	MUMFORD	B	NATIONAL	B	NEWMARKET	B
MINNEISKA	C	MONTEVALLO	D	MUNDELEIN	B	NATRONA	B	NEWPORT	C
MINNEOSA	B	MONTGOMERY	D	MUNDOS	B	NATROY	D	NEWRUSS	B
MINNEQUA	B	MONTICELLO	B	MUNISING	B	NATURITA	B	NEWRY	B
MINNETONKA	D	MONTIETH	A	MUNK	C	NAUKATI	D	NEWSKAH	B
MINNEWAUKAN	B	MONTMORENCI	B	MUNSON	D	NAUMBURG	C	NEWSTEAD	D
MINNIECE	D	MONTOSO	B	MUNUSCONG	D	NAVAJO	D	NEWTON	A/D
MINOA	C	MONTOUR	D	MURDO	B	NAVAN	D	NEWTONIA	B
NEWTOWN	C	NORTON	C	OKAW	D	ORELLA	D	PACK	C
NEWVILLE	C	NORTONVILLE	C	OKAY	B	OREM	A	PACKARD	B
NEZ PERCE	C	NORTUNE	D	OKEECHOBEE	A/D	ORESTIMBA	C	PACKER	C
NIAGARA	C	NORWALK	B	OKEELANTA	A/D	ORFORD	C	PACKHAM	B
NIART	B	NORWAY FLAT	B	OKEMAH	C	ORIDIA	C	PACKSADDLE	B
NIBLEY	C	NORWELL	C	OKLARED	B	ORIF	A	PACKWOOD	D
NICHOLSON	C	NORWICH	D	OKLAWAHA	A/D	ORIO	C	PACOLET	B
NICHOLVILLE	C	NORWOOD	B	OKMOK	B	ORION	B	PACTOLUS	C
NICKEL	B	NOTI	D	OKO	D	ORITA	B	PADEN	C
NICODEMUS	B	NOTUS	A/C	OKOBOJI	C	ORLAND	B	PADRONI	B
NICOLAUS	C	NOUQUE	D	OKOLONA	D	ORLANDO	A	PADUCAH	B
NICOLLET	B	NOVARA	B	OKREEK	D	ORMAN	C	PADUS	B
NIELSEN	D	NOVARY	B	OKTIBBEHA	D	ORMSBY	B/C	PAESL	B
NIGHTHAWK	B	NOWOOD	C	OLA	C	ORODELL	C	PAGET	B
NIHILL	B	NOYO	C	OLAA	A	ORO FINO	B	PAGODA	C

NIKABUNA	D	NOYSON	C	OLALLA	C	ORO GRANDE	C	PAHRANAGAT	C
NIKEY	B	NUBY	C/D	OLANTA	B	ORONO	D	PAHREAH	D
NIKISHKA	A	NUCKOLLS	C	OLATHE	C	OROVADA	C	PAHROC	D
NIKLASON	B	NUCLA	B	OLD CAMP	D	ORPHANT	D	PAIA	C
NIKOLAI	D	NUECES	C	OLDHAM	C	ORR	C	PAICE	C
NILAND	C	NUGENT	A	OLDS	D	ORVILLE	C	PAINESVILLE	C
NILES	C	NUGGET	C	OLDSMAR	B/D	ORSA	A	PAINTROCK	C
NIMROD	C	NUMA	C	OLDWICK	B	ORSINO	A	PAIT	B
NINCH	C	NUNDA	C	OLELO	B	ORTELLO	A	PAJARITO	B
NINEMILE	D	NUNICA	C	OLENA	B	ORTIGALITA	C	PAJARO	C
NINEVEH	B	NUNN	C	OLEQUA	B	ORTING	C	PAKA	B
NINIGRET	B	NUSS	D	OLETE	C	ORTIZ	C	PAKALA	B
NININGER	B	NUTLEY	C	OLEX	B	ORTLEY	B	PAKINI	B
NINNESCAH	B	NUTRAS	C	OLGA	C	ORWET	A	PALA	B
NIOBELL	C	NUTRIOSO	B	OLI	B	ORWOOD	B	PALACIO	B
NIOTA	D	NUVALDE	C	OLIAGA	B/D	OSAGE	D	PALAPALAI	B
NIPE	B	NYALA	D	OLINDA	B	OSAKIS	B	PALATINE	B
NIPPERSINK	B	NYMORE	A	OLIPHANT	B	OSCAR	D	PALESTINE	B
NIPPT	A	NYSSA	C	OLIVENHAIN	D	OSCURA	C	PALISADE	B
NIPSUM	C	NYSSATON	B	OLIVER	B	OSGOOD	B	PALMA	B
NIRA	B	NYSTROM	C	OLIVIER	C	OSHA	B	PALMAREJO	C
NISHNA	C			OLJETO	A	OSHAWA	D	PALM BEACH	A
NISHON	D	OAHE	B	OLMITO	D	O'SHEA	C	PALMER	D
NISQUALLY	A	OAKDALE	B	OLMITZ	B	OSHKOSH	C	PALMER CANYON	B
NISSWA	B	OAKDEN	D	OLMOS	C	OSHTEMO	B	PALMICH	B
NIU	B	OAKFORD	B	OLMSTFD	B/D	OSIER	B/D	PALMS	D
NIULII	C	OAK GLEN	B	OLNEY	B	OSKA	C	PALMYRA	B
NIVLOC	D	OAK GROVE	C	OLOKUI	D	OSMUND	B	PALO	B
NIWOT	C	OAK LAKE	B	OLPE	C	OSO	B	PALDOURO	B
NIXA	C	OAKLAND	C	OLSON	D	OSOBB	D	PALOMAS	B
NIXON	B	OAKS RIDGE	C	OLTON	C	OSORIDGE	D	PALOMINO	D
NIXONTON	B	OAKVILLE	A	OLUSTEE	B/D	OSOTE	B	PALOS VERDES	B
NIZINA	A	OAKWOOD	D	OLYIC	B	OSSIAN	C	PALOUSE	B
NOBE	D	OANAPUKA	B	OLYMPIC	B	OST	B	PALSGROVE	B
NOBLE	B	OASIS	B	OMADI	B	OSTRANDER	B	PAMLICO	D
NOBSCOTT	A	OATMAN	B	OMAHA	B	OTERO	B	PAMOA	C
NOCKEN	C	OBAN	C	OMAK	C	OTHELLO	D	PAMSDEL	D
NODAWAY	B	OBARC	B	OMEGA	A	OTIS	C	PAMUNKEY	C

NOEL	D	OBEN	C	OMENA	B	OTISCO	A	PANA	B
NOHILI	D	OBRAST	D	OMNI	C	OTISVILLE	A	PANACA	D
NOKASIPPI	D	OBRAY	D	ONA	A/D	OTLEY	B	PANAEWA	D
NOKAY	C	OBURN	D	ONALASKA	B	OTSEGO	C	PANASOFFKEE	D
NOKOMIS	B	OCALA	D	ONAMIA	B	OTTER	B/D	PANCHERI	B
NOLAM	B	OCEANET	D	ONARGA	B	OTTERBEIN	C	PANCHUELA	C
NOLICHUCKY	B	OCEANO	A	ONAWA	D	OTTERHOLT	B	PANDO	B
NOLIN	B	OCHEYEDAN	B	ONAWAY	B	OTTOKEE	A	PANDOAH	C
NOLO	B	OCHLOCKONEE	B	ONDAWA	B	OTWAY	D	PANDORA	D
NOME	D	OCHO	D	ONEIDA	B	ORTWELL	C	PANDURA	D
NONDALTON	B	OCHOCO	C	O'NEILL	B	OUACHITA	C	PANE	B
NONOPAHU	D	OCHOPEE	B/D	ONEONTA	B	OURAY	A	PANGUITCH	B
NOOKACHAMPS	C/D	OCILLA	C	ONITRA	C	OUTLET	C	PANHILL	B
NOOKSACK	B	OCKLEY	B	ONITE	B	OVALL	C	PANIOGUE	B
NOONAN	D	OCDEE	A/D	ONOTA	C	OVERGAARD	C	PANKY	C
NORA	B	OCONEE	C	ONOVA	D	OVERLAND	C	PANOCHE	B
NORAD	B	OCONTO	B	ONRAY	C	OVERLY	C	PANOLA	D
NORBERT	D	OCOSTA	D	ONSLOW	B	OVERTON	D	PANSEY	D
NORBOURNE	B	OCQUEOC	B	ONTARIO	B	OVID	C	PANTEGO	D
NORBY	B	OCTAGON	B	ONTKO	B/D	OVINA	B	PANTHER	D
NORD	B	ODEE	D	ONTONAGON	D	OWEGO	D	PANTON	D
NORDBY	B	ODELL	B	ONYX	B	OWEN CREEK	C	PAOLA	A
NORDEN	B	ODEM	A	OOKALA	A	OWENS	D	PAOLI	B
NORDNESS	B	ODERMOTT	C	OPAL	D	OWHI	B	PAONIA	C
NORFOLK	B	ODESSA	D	OPEQUON	C/D	OWOSSO	B	PAPAA	D
NORGE	B	ODIN	C	OPHIR	C	OWYHEE	B	PAPAI	A
NORKA	B	ODNE	C	OPIHIKAO	D	OXALIS	C	PAPAKATING	D
NORMA	B/C	O'FALLON	D	OPPIO	D	OXBOW	C	PAPOOSE	C
NORMANGEE	D	OGDEN	D	OQUAGA	C	OXERINE	C	PARADISE	C
NORREST	C	OGEECHEE	C	ORA	C	OXFORD	D	PARADOX	B
NORRIS	C	OGEMAW	C	ORAN	B	OZAMIS	B/D	PARALOMA	C
NORRISTON	B	OGILVIE	C	ORANGE	D	OZAN	D	PARAMORE	D
NORTE	B	OGLALA	B	ORANGEBURG	B	OZAUKEE	C	PARASOL	B
NORTHDALE	C	OGLE	B	ORCAS	D			PARCELAS	D
NORTHFIELD	B	OHAYSI	D	ORCHARD	B	PAAIKI	B	PARDEE	D
NORTHMORE	C	OHIA	A	ORD	A	PAALOA	B	PAREHAT	C
NORTHPORT		OJAI	B	ORDNANCE	C	PAAUHAU	A	PARENT	C
NORTH POWDER	C	OJATA	D	ORDWAY	D	PACHAPPA	B	PARIETTE	C

NORTHUMBERLAND	C/D	OKANOGAN	B	ORELIA	D	PACHECO	B/C	PARIS	
PARISHVILLE	C	PELIC	D	PICAYUNE	B	PLEASANT VIEW	B	POSE	D
PARKAY	B	PELLA	D	PICKAWAY	C	PLEDGER	D	POTAMO	D
PARKDALE	B	PELLEJAS	B	PICKENS	D	PLEEK	C	POTH	C
PARKE	B	PELONA	C	PICKETT	B	PLEINE	D	POTLATCH	C
PARKER	B	PELUK	D	PICKFORD	D	PLEVNA	D	POTRATZ	C
PARKFIELD	C	PEMBERTON	A	PICKRELL	D	PLOME	B	POTSDAM	B
PARKHILL	D	PEMBINA	C	PICKWICK	B	PLOVER	B	POTTER	C
PARKHURST		PEMBROKE	B	PICO	B	PLUMAS	B	POTTS	B
PARKINSON	B	PENA	B	PICOSA	C	PLUMMER	B/D	POUDRE	B
PARKVIEW	B	PENCE	A	PICTOU	B	PLUSH	B	POULTNEY	B
PARKVILLE	C	PENDEN	B	PIE CREEK	D	PLUTH	B	POUNCEY	D
PARKWOOD	A/D	PEND OREILLE	B	PIERIAN	A	PLUTOS	C	POVERTY	A
PARLEYS	B	PENDROY	D	PIERPONT	C	PLYMOUTH	A	POWDER	B
PARLIN	C	PENELAS	D	PIERRE	D	POALL	C	POWDERHORN	C
PARLO	B	PENINSULA	C	PIERSONTE	B	POARCH	B	POWELL	C
PARMA	C	PENISTAJA	B	PIIHONUA	A	POCALLA	A	POWER	B
PARNELL	D	PENITENTE	B	PIKE	B	POCATELLO	B	POWHITE	C
PARR	B	PENLAW	C	PILCHUCK	A	POCKER	D	POWLEY	D
PARRAN	D	PENN	C	PILGRIM	B	POCOMOKE	D	POWWATKA	C
PARRISH	C	PENNEL	C	PILOT	B	PODO	D	POY	D
PARSHALL	B	PENNINGTON	B	PILOT ROCK	C	PODUNK	B	POYGAN	D
PARSIPPANY	D	PENO	C	PIMA	B	POE	B/C	POZO	C/D
PARSONS	D	PENOYER	C	PIMER	B	POEVILLE	D	POZO BLANCO	B
PARTRI	C	PENROSE	D	PINAL	D	POGAL	B	PRAG	C
PASAGSHA	D	PENSORE	D	PINALENO	B	POGANEAB	D	PRATHER	B
PASCO	B/C	PENTHOUSE	D	PINAMT	B	POGUE	B	PRATLEY	C
PASO SECO	D	PENTZ	D	PINATA	C	POHAKUPU	A	PRATT	A
PASQUETTI	C/D	PENWELL	A	PINAVETES	A	POINDEXTER	C	PREACHER	B
PASQUOTANK	B/D	PENWOOD	A	PINCHER	C	POINSETT	B	PREAKNESS	D
PASSAR	C	PEOGA	C	PINCKNEY	C	POINT	B	PREBISH	D
PASS CANYON	D	PEOH	C	PINCONNING	D	POINT ISABEL	C	PREBLE	C
PASSCREEK	C	PEONE	B/C	PINCUSHION	B	POJOAQUE	B	PRENTISS	C
PASTURA	D	PEORIA	D	PINEDA	B/D	POKEGEMA	B	PRESQUE ISLE	B
PATAHS	B	PEOTONE	C	PINEDALE	B	POKEMAN	B	PRESTO	A
PATENT	C	PEPOON	B	PINEGUEST	B	POKER	C	PRESTON	A
PATILLAS	B	PEQUEA	C	PINELLOS	A/D	POLAND	B	PREWITT	B
PATILO	C	PERCHAS	D	PINETOP	C	POLAR	B	PREY	D

PATIT CREEK	B	PERCIVAL	C	PINEVILLE	B	POLATIS	C	PRICE	C
PATNA	B	PERELLA	C	PINEY	C	POLE	A	PRIDA	D
PATOUTVILLE	C	PERHAM	C	PINICON	B	POLEBAR	C	PRIDHAM	D
PATRICIA	B	PERICO	B	PINKEL	C	POLELINE	B	PRIETA	D
PATRICK	B	PERITSA	C	PINKHAM	B	POLEO	B	PRIMEAUX	C
PATROLE	C	PERKINS	C	PINKSTON	B	POLEY	C	PRIMGHAR	B
PATTANI	D	PERKS	A	PINNACLES	C	POLICH	B	PRINCETON	B
PATTENBURG	B	PERLA	C	PINO	C	POLLARD	C	PRINEVILLE	C
PATTER	C	PERMA	A	PINOLA	C	POLLASKY	C	PRING	B
PATTERSON	C	PERMANENTE	C	PINOLE	B	POLLY	B	PRINS	C
PATTON	B/D	PERRIN	B	PINON	C	POLO	B	PRITCHETT	C
PATWAY	C	PERRINE	D	PINONES	D	POLSON	C	PROCTOR	B
PAUL	B	PERROT	D	PINTAS	D	POLVADERA	B	PROGRESSO	C
PAULDING	D	PERRY	D	PINTLAR	A	POMAT	C	PROMISE	D
PAULINA	D	PERRYPARK	B	PINTO	C	POMELLO	C	PROMO	D
PAULSELL	D	PERRYVILLE	B	PINTURA	A	POMPANO	A/D	PROMONTORY	B
PAULSON	B	PERSANTI	C	PINTWATER	D	POMPONIO	C/D	PRONG	C
PAULVILLE	B	PERSAYO	D	PIOCHE	D	POMPTON	B	PROSPECT	B
PAUMALU	B	PERSHING	C	PIOPOLIS	D	POMROY	B	PROSPER	B
PAUNSAUGUNT	D	PERSIS	B	PIPER	B/C	PONCA	B	PROSSER	C
PAUSANT	B	PERT	D	PIROUETTE	D	PONCENA	D	PROTIVIN	C
PAUWELA	B	PERU	C	PIRUM	B	PONCHA	A	PROUT	C
PAVANT	D	PESCADERO	C/D	PISGAH	C	POND	B/C	PROVIDENCE	C
PAVILLION	B	PESET	C	PISHKUN	B	POND CREEK	B	PROVO	D
PAVOHROO	B	PEHASTIN	B	PISTAKEE	B	PONDILLA	A	PROVO BAY	D
PAWCATUCK	D	PESO	C	PIT	D	PONIL	D	PROWERS	B
PAWLET	B	PETEETNEET	D	PITTMAN	D	PONTOTOC	B	PTARMIGAN	B
PAWNEE	D	PETERBORO	B	PITTSFIELD	B	PONZER	D	PUAULU	A
PAXTON	C	PETERS	D	PITTSTOWN	C	POOKU	A	PUCHYAN	A
PAXVILLE	D	PETOSKEY		PITTWOOD	B	POOLE	B/D	PUDDLE	D
PAYETTE	B	PETRIE	D	PITZER	C	POOLER	D	PUERCO	D
PAYMASTER	B	PETROLIA	D	PIUTE	D	POORMA	B	PUERTA	D
PAYNE	C	PETTONS	C	PLACEDO	D	POPE	B	PUETT	D
PAYSON	D	PEWAMO	B/D	PLACENTIA	D	POPPLETON	A	PUGET	B/C
PEACHAM	D	PEYTON	B	PLACERITOS	C	POQUONOCK	C	PUGSLEY	B
PEARL HARBOR	D	PFEIFFER	B	PLACID	A/D	PORRETT	B/D	PUHI	A
PEARMAN		PHAGE	B	PLACK	D	PORT	B	PUHIMAU	D
PEARSOLL	D	PHANTOM	C	PLAINFIELD	A	PORTAGEVILLE	D	PULASKI	B

PEAVINE	C	PHARO	B	PLAINVIEW	C	PORTALES	B	PULEHU	B
PECATONICA	B	PHAROLIO	D	PLAISTED	C	PORTALTO	B	PULLMAN	D
PECOS	D	PHEBA	C	PLANO	B	PORT BYRON	B	PULS	D
PEDEE	C	PHEENEY	B	PLASKETT	D	PORTERS	B	PULSIPHER	D
PEDERNALES	C	PHELAN	B	PLATA	B	PORTERVILLE	D	PULTNEY	C
PEDIGO	B/C	PHELPS	B	PLATEA	C	PORTHILL	C	PUMEL	C
PEDLAR	D	PHIFERSON	B	PLATEAU	B	PORTINO	C	PUMPER	C
PEDOLI	C	PHILBON	B/D	PLATNER	C	PORTLAND	D	PUNA	A
PEDRICK	B	PHILIPSBURG	B	PLATO	C	PORTNEUF	B	PUNALUU	D
PEBBLES	C	PHILLIPS	C	PLATORO	B	PROTOLA	C	PUNOHU	A
PEEL	C	PHILO	B	PLATTE	D	PORTSMOUTH	D	PURDAM	C
PEELER	B	PHILOMATH	D	PLATTVILLE	B	PORUM	C	PURDY	D
PEEVER	C	PHIPPS	C	PLAZA	B/C	POSANT	C	PURGATORY	D
PEGLER	D	PHOEBE	B	PLEASANT	C	POSEY	B	PURNER	D
PEGRAM	B	PHOENIX	D	PLEASANT GROVE	B	POSITAS	D	PURSLEY	B
PEKIN	C	PIASA	D	PLEASANTON	B	POSKIN	C	PURVES	D
PELHAM	B/D	PICACHO	C	PLEASANT VALE	B	POSOS	C	PUSTOI	A
PUTNAM	D	RANDMAN	D	REELFOOT	C	RIFFE	B	ROLETTE	C
PUUKALA	D	RANDOLPH	D	REESER	C	RIFLE	A/D	ROLFE	C
PUUONE	C	RANDS	C	REESVILLE	C	RIGA	D	ROLISS	D
PUU OO	A	RANGER	D	REEVES	C	RIGGINS	A	ROLLA	C
PUU OPAE	B	RANIER	C	REFUGE	C	RIGLEY	B	ROLLII	D
PUU PA	B	RANKIN	C	REGAN	B	RILEY	C	ROLOFF	C
PUYALLUP	B	RANTOUL	D	REGENT	C	RILLA	B	ROMBERG	B
PYLE	A	RANYHAN	B	REHM	C	RILLITO	B	ROMBO	C
PYLON	D	RAPELJE	C	REICHEL	B	RIMEI	C	ROMEO	C
PYOTE	A	RAPHO	B	REIFF	B	RIMINI	A	ROMNEY	C
PYRAMID	D	RAPIDAN	B	REILLY	A	RIMROCK	D	ROMULUS	D
PYRMONT	D	RAPLEE	C	REINACH	B	RIN	B	ROND	C
		RARDEN	C	REKOP	D	RINCON	C	RONNEBY	B
QUACKENBUSH	C	RARICK	B	RELAN	A	RINCONADA	C	RONSON	B
QUAKER	C	RARITAN	C	RELAY	B	RINDGE	D	ROOSE	B
QUAKERTOWN	B	RASBAND	B	RELIANCE	C	RINGLING	C	ROOTEL	D
QUANBA	D	RASSET	B	RELIZ	D	RINGO	D	ROSACHI	C
QUAMON	A	RATAKE	C	RELSE	B	RINGOLD	B	ROSAMOND	B
QUANAH	B	RATHBUN	C	REMBERT	D	RINGWOOD	B	ROSANE	C
QUANDAHL	B	RATLIFF	B	RENMIT	A	RIO	D	ROSANKY	C
QUARLES	D	RATON	D	REMSEN	D	RIO ARRIBA	D	ROSARIO	C

QUARTZBURG	C
QUATAMA	C
QUAY	B
QUAZO	D
QUEALY	D
QUEBRADA	C
QUEENY	D
QUEETS	B
QUEMADO	C
QUENZER	D
QUICKSELL	D
QUIETUS	C
QUIGLEY	B
QUILCENE	C
QUILLLAYUTE	B
QUIMBY	B
QUINCY	A
QUINLAN	C
QUINN	D
QUINNEY	C
QUINTON	
QUITMAN	C
QUONSET	A
RABER	C
RABEY	A
RABIDEUX	B
RABUN	B
RACE	D
RACHERT	D
RACINE	B
RACOON	D
RAD	C
RADERSBURG	B
RADFORD	B
RADLEY	C
RADNOR	D
RAFAEL	D
RATTLER	B
RATTO	D
RAUB	B
RAUVILLE	D
RAUZI	B
RAVALLI	C
RAVENDALE	D
RAVENNA	C
RAVOLA	B
RAWAH	B
RAWHIDE	D
RAWSON	B
RAY	B
RAYADO	C
RAYENOUF	B
RAYMONDVILLE	D
RAYNE	B
RAYNESFORD	B
RAYNHAM	C
RAYNOR	D
RAZOR	C
RAZORT	B
READING	C
READINGTON	C
READLYN	B
REAGAN	B
REAKOR	B
REAL	C
REAP	D
REARDAN	C
REAVILLE	C
REBA	C
REBEL	B
REBUCK	
RECAL	D
RECLUSE	C
REDBANK	B
RED BAY	B
REMUDAR	B
REMUNDA	C
RENBAC	D
RENCALSON	C
RENCOT	A
RENFROW	D
RENICK	D
RENNIE	C/D
RENO	D
RENOHILL	C
RENOVA	D
RENOX	B
RENSHAW	B
RENSLOW	B
RENSSELAER	C
RENTIDE	C
RENTON	B/C
RENTSAC	C
REPARADA	D
REPP	A
REPPART	B
REPUBLIC	B
RESCUE	C
RESERVE	B
RESNER	B
RET	B/C
RETRIEVER	D
RETSOF	C
RETSOK	B
REXBURG	B
REXFORD	C
REXOR	A
REYES	C/D
REYNOLDS	
REYNOSA	B
REYWAT	D
RHAME	B
RHEA	B
RIOCONCHO	C
RIO GRANDE	B
RIO KING	C
RIO LAJAS	A
RIO PIEDRAS	B
RIPLEY	B
RIPON	B
RIRIE	B
RISBECK	B
RISLEY	D
RISTA	C
RISUE	D
RITCHEY	B
RITNER	C
RITO	B
RITTER	B
RITTMAN	C
RITZ	B/D
RITZCAL	B
RITZVILLE	B
RIVERHEAD	B
RIVERSIDE	A
RIVERTON	C
RIVERVIEW	B
RIVRA	A
RIXIE	C
RIXON	C
RIZ	D
ROANOKE	D
ROBANA	B
ROBBINS	B
ROBBS	D
ROBERTS	D
ROBERTSDALE	C
ROBERTSVILLE	D
ROBIN	B
ROBINSON	D
ROBINSONVILLE	B
ROSCOE	D
ROSCOMMON	D
ROSEBERRY	B/D
ROSEBLOOM	D
ROSEBUD	B
ROSEBURG	B
ROSE CREEK	C
ROSEGLEN	B
ROSEHILL	D
ROSELAND	D
ROSELLA	D
ROSELMS	D
ROSEMOUNT	B
ROSENDALE	B
ROSE VALLEY	C
ROSEVILLE	B
ROSEWORTH	C
ROSHE SPRINGS	D
ROSITAS	A
ROSLYN	B
ROSMAN	B
ROSNEY	C
ROSS	B
ROSE FORK	C
ROSSI	C
ROSSMOYNE	C
ROSS VALLEY	C
ROTAN	C
ROTHIEMAY	B
ROTHSAY	B
ROTTULEE	B
ROUBIDEAU	C
ROUEN	C
ROUND BUTTE	D
ROUNDLEY	C
ROUNDTOP	C
ROUNDUP	C
ROUNDY	C

RAGER	B	RED BLUFF	C	RHINEBECK	D	ROBLEDO	D	ROUSSEAU	A
RAGLAN	C	RED BUTTE	B	RHOADES	D	ROB ROY	C	ROUTON	D
RAGNAR	B	REDBY	C	RHOAME	C	ROBY	C	ROUTT	C
RAGO	C	REDCHIEF	C	RIB	C	ROCA	D	ROVAL	D
RAGSDALE	B/D	REDCLOUD	B	RICCO	D	ROCHE	C	ROWE	D
RAGTOWN	D	REDDICK	C	RICETON	B	ROCHELLE	C	ROWENA	C
RAHAL	C	REDDING	D	RICEVILLE	C	ROCHEPORT	C	ROWLAND	C
RAHM	C	REDFIELD	B	RICHARDSON	B	ROCKAWAY	C	ROWLEY	B
RAIL	C/D	RED HILL	C	RICHEAU	C	ROCKCASTLE	D	ROXAL	D
RAINBOW	C	RED HOOK	C	RICHEY	C	ROCK CREEK	D	ROXBURY	B
RAINEY	B	REDLAKE	D	RICHFIELD	C	ROCKFORD	B	ROY	B
RAINS	B/D	REDLANDS	B	RICHFORD	A	ROCKHOUSE	A	ROYAL	B
RAINSBORO	C	REDLODGE	D	RICHLIE	A	ROCKINGHAM	C/D	ROYALTON	C
RAKE	D	REDMANSON	B	RICHMOND	D	ROCKLIN	C/D	ROYCE	B
RALSEN	B/C	REDMOND	C	RICHTER	B	ROCKLY	D	ROYSTONE	B
RAMADA	C	REDNUN	C	RICHVALE	B	ROCKPORT	C	ROZA	D
RAMADERO	B	REDOLA	B	RICHVIEW	C	ROCK RIVER	B	ROZELLVILLE	B
RAMBLER	B	REDONA	B	RICHWOOD	B	ROCKTON	B	ROZETTA	B
RAMELLI	C	REDRIDGE	B	RICKMORE	C	ROCKWELL	B	ROZLEE	C
RAMIRES	D	REDROB	D	RICKS	A	ROCKWOOD	B	RUARK	C
RAMMEL	C	RED ROCK	B	RICO	C	ROCKY FORD	B	RUBICON	A
RAMO	C	RED SPUR	B	RICREST	B	RODDY		RUBIO	C
RAMONA	B	REDSTOE	B	RIDD	C	RODMAN	A	RUBY	B
RAMPART	B	REDTHAYNE	B	RIDGEBURY	C	ROE	B	RUBYHILL	C
RAMPARTAR	A	REDTOM	C	RIDGECREST	C	ROEBUCK	D	RUCH	B
RAMPARTER	A	REDVALE	C	RIDGEDALE	B	ROELLEN	D	RUCKLES	D
RAMSEY	D	REDVIEW	C	RIDGELAND	D	ROEMER	C	RUCLICK	C
RAMSHORN	B	REE	B	RIDGELAWN	A	ROESIGER	B	RUDD	D
RANCE	C	REEBEX	C	RIDGELY	B	ROGERT	D	RUDEEN	B
RANCHERIA	B	REED	D	RIDGEVILLE	B	ROHNERVILLE	B	RUDOLPH	C
RAND	B	REEDER	B	RIDGEWAY	D	ROHRERSVILLE	C	RUDYARD	D
RANDADO	C	REEDPOINT	C	RIDIT	C	ROIC	D	RUELLA	B
RANDALL	D	REEDY	D	RIETBROCK	C	ROKEBY	D	RUGGLES	B
RUIDOSO	C	SALVISA	C	SAUK	B	SEDAN		SHELBY	B
RUKO	D	SALZER	D	SAULICH	D	SEDILLO	B	SHELBYVILLE	B
RULE	B	SAMBA	D	SAUM	C	SEDWELL	C	SHELDON	
RULICK	C	SAMISH	C/D	SAUNDERS	C	SEEDSKADEE	D	SHELIKOF	D
RUMBO	C	SAMMAMISH	C	SAUVIE	C/D	SEES	C	SHELLABARGER	B

RUMFORD	B	SAMPSEL	D	SAUVOLA	C	SEEWEE	B	SHELLDRAKE	A
RUMNEY	C	SAMPSON	B	SAVAGE	C	SEGAL	D	SHELLROCK	A
RUMPLE	C	SAMSIL	D	SAVANNAH	C	SEGNO	C	SMELMADINE	D
RUM RIVER	C	SAN ANDREAS	C	SAVENAC	C	SEHORN	D	SHELOCTA	B
RUNE	C	SAN ANTON	B	SAVO	C	SEITZ	C	SHELTON	C
RUNGE	B	SAN ANTONIO	C	SAVOIA	B	SEJITA	D	SHENA	C
RUNNELLS	C	SAN ARCACIO	B	SAWABE	D	SEKIL	C	SHENANDOAH	C
RUNNYMEDE	B	SAN BENITO	B	SAWATCH	C	SEKIU	D	SHEP	B
RUPERT	A	SANCHEZ	D	SAWCREEK	B	SELAH	C	SHEPPARD	A
RUSCO	C	SANDALL	C	SAWMILL	C	SELDEN	C	SHERANDO	A
RUSE	D	SANDERSON	B	SAWYER	C	SELEGNA	D	SHERAR	C
RUSH	C	SANDLAKE	C	SAXBY	D	SELFRIDGE	C	SHERBURNE	B
RUSHTOWN	A	SANDLEE	A	SAXON	B	SELKIRK	D	SHERIDAN	B
RUSHVILLE	D	SANELI	D	SAYBROOK	B	SELLE	B	SHERLOCK	B
RUSS	B	SAN EMIGDIO	B	SAYLESVILLE	C	SELLERS	A/D	SHERM	D
RUSSELL	B	SANFORD	A	SAYLOR	A	SELMA	B	SHERRYL	B
RUSSELLVILLE	C	SANGER	B	SCALA	B	SEMIAHMOO	D	SHERWOOD	B
RUSSLER	C	SAN GERMAN	D	SCAMMAN	C	SEMIHMOO	D	SHIBLE	B
RUSTON	B	SANGO	C	SCANDIA	B	SEMINARIO	D	SHIELDS	C
RUTLAND	C	SANGREY	A	SCANTIC	C	SEMIX	C	SHIFFER	B
RUTLEGE	D	SANILAC	C	SCAR	A	SEN	B	SHILOH	C
RYAN	D	SAN ISABEL	B	SCARBORO	D	SENECAVILLE	C	SHINAKU	D
RYAN PARK	B	SAN JOAQUIN	D	SCAVE	C	SEQUATCHIE	B	SHINGLE	D
RYDE	B/D	SAN JON	C	SCHAFFENAKEN	A	SEQUIM	A	SHINGLETOWN	C
RYDER	C	SAN JOSE	B	SCHAMBER	A	SEQUIN	B	SHINN	B
RYEGATE	B	SAN JUAN	A	SCHAMP	C	SEQUOIA	C	SHINROCK	C
RYELL	A	SAN LUIS	B	SCHAPVILLE	C	SERENE	D	SHIOCTON	B
RYEPATCH	D	SAN MATEO	B	SCHEBLY	D	SERNA	D	SHIPLEY	C
RYER	C	SAN MIGUEL	C	SCHERRARD	D	SEROCO	A	SHIPROCK	B
RYORP	C	SANPETE	B	SCHLEY	B	SERPA	C/D	SHIRAT	B
RYUS	C	SANPITCH	C	SCHMUTZ	B	SERVOSS	D	SHIRK	C
		SAN POIL	B	SCHNEBLY	D	SESAME	C	SHOALS	C
SABANA	D	SAN SABA	D	SCHNEIDER	C	SESPE	C	SHOEBAR	B
SABANA SECA	D	SAN SEBASTIAN	B	SCHNOGRSON	B/D	SESSIONS	C	SHOEFFLER	B
SABENYO	B	SANTA	C	SCHNORBUSH	C	SESSUM	D	SHONKIN	D
SABINA	C	SANTA CLARA	C	SCHODACK		SETTERS	C	SHOOFLIN	C
SABINE	A	SANTA FE	D	SCHOOSON	C	SETTLEMEYER	D	SHOOK	A
SABLE	D	SANRTA ISABEL	D	SCHOFIELD	B	SEVAL	D	SHOREWOOD	C

SAC	B
SACO	D
SACRAMENTO	C/D
SACUL	D
SADDLE	B
SADDLEBACK	B
SADER	D
SADIE	B
SADLER	C
SAFFELL	B
SAGANING	D
SAGE	D
SAGEHILL	B
SAGEMOOR	C
SAGERTON	C
SAGINAW	
SAGO	D
SAGOUSPE	C
SAGUACHE	A
SAHALIE	B
SAINT HELENS	A
SAINT MARTIN	C
SALADO	B
SALADON	D
SALAL	B
SALAMATOF	D
SALAS	C
SALCHAKET	B
SALEM	B
SALEMSBURG	B
SALGA	C
SALIDA	A
SALINAS	C
SALISBURY	D
SALIX	B
SALKUM	C
SALLISAW	B
SALLYANN	C
SANTA LUCIA	C
SANTA MARTA	C
SANTANA	C
SANTAQUIN	A
SANTA YNEZ	C
SANTEE	D
SANTIAGO	B
SANTIAM	C
SAN TIMOTEO	C
SANTONI	D
SANTOS	C
SANTO TOMAS	B
SAN YSIDRO	D
SAPINERO	B
SAPP	D
SAPPHIRE	B
SAPPHO	B
SAPPINGTON	B
SARA	C
SARALEGUI	B
SARANAC	D
SARAPH	D
SARATOGA	B
SARATON	B
SARBEN	A
SARCO	B
SARDINIA	C
SARDO	B
SARGEANT	D
SARITA	A
SARKAR	D
SARPY	A
SARTELL	A
SASKA	B
SASPAMCO	B
SASSAFRAS	B
SASSER	B
SATANKA	C
SCHOHARIE	C
SCHOLLE	B
SCHOOLEY	C/D
SCHOONER	D
SCHRADER	D
SCHRAP	D
SCHRIER	B
SCHROCK	B
SCHUMACHER	B
SCHUYLKILL	B
SCIO	B
SCIOTOVILLE	C
SCISM	B
SCITUATE	C
SCOBEY	C
SCOOTENEY	B
SCORUP	C
SCOTT	D
SCOTT LAKE	B
SCOUT	B
SCOWLALE	C
SCRANTON	B/D
SCRAVO	A
SCRIBA	C
SCRIVER	B
SCROGGIN	C
SCULLIN	C
SEABROOK	C
SEAMAN	C
SEAQUEST	C
SEARCHLIGHT	C
SEARING	B
SEARLA	B
SEARLES	C
SEATON	B
SEATTLE	D
SEAWILLOW	B
SEBAGO	D
SEVERN	B
SEVILLE	D
SEVY	C
SEWARD	B
SEWELL	B
SEXTON	D
SEYMOUR	C
SHAAK	D
SHADELAND	C
SHAFFER	A
SHAKAN	B
SHAKESPEARE	C
SHAKOPEE	C
SHALCAR	D
SHALET	D
SHAM	D
SHAMBO	B
SHAMEL	B
SHANAHAN	B
SHANDON	
SHANE	D
SHANO	B
SHANTA	B
SHAPLEIGH	C/D
SHARATIN	B
SHARKEY	D
SHARON	B
SHARPSBURG	B
SHARROTT	D
SHARVANA	C
SHASKIT	B/C
SHASTA	A
SHAVANO	B
SHAVER	B
SHAWA	B
SHAWANO	A
SHAWMUT	B
SHAY	D
SHOREY	B
SHORN	B
SHORT CREEK	D
SHOSHONF	D
SHOTWELL	D
SHOUNS	B
SHOWALTER	C
SHOWLOW	C
SHREWSBURY	D
SHRINE	B
SHROE	D
SHROUTS	D
SHUBUTA	C
SHULE	B
SHULLSBURG	C
SHUNWAY	B
SHUPERT	C
SHUWAH	B
SI	B
SIBLEYVILLE	B
SIBYLEE	D
SICILY	B
SICKLESTEETS	C
SIDELL	B
SIEANCIA	B
SIEBER	A
SIELO	C
SIEROCLIFF	D
SIERRA	B
SIERRAVILLE	B
SIESTA	D
SIFTON	B
SIGNAL	C
SIGURD	B
SIKESTON	D
SILCOX	B
SILENT	D
SILER	B

SALMON	B	SATANTA	B	SEBASTIAN	D	SHEAR	C	SILERTON	B
SALOL	D	SATELLITE	C	SEBASTOPOL	C	SHECKLER	C	SILI	D
SALONIE	D	SATT	D	SEBEKA	D	SHEDADO	B	SILSTID	A
SALREE	C/D	SATTLEY	B	SEBEWA	B/D	SHEDD	C	SILVER	C
SALTAIR	D	SATTRE	B	SEBREE	D	SHEEGE	D	SILVERADO	C
SALT CHUCK	A	SATURN	B	SEBRING	D	SHEEP CREEK	C	SILVERBOW	D
SALTER	B	SATUS	B	SEBUD	B	SHEEPHEAD	C	SILVER CREEK	D
SALTERY	D	SAUCIER	B	SECATA	C/D	SHEEPROCK	A	SILVERTON	C
SALT LAKE	D	SAUDE	B	SECCA	C	SHEETIRON	B	SILVIES	D
SALUDA	C	SAUGATUCK	C	SECRET	C	SHEFFIELD	D	SIMAS	C
SALUVIA		SAUGUS	B	SECRET CREEK	B	SHELBURNE	C	SIMCOE	C
SIMEON	A	SNOW	B	SQUALICUM	B	STISSING	C	SURGH	B
SIMMLER	D	SNOWDEN	C	SQUAW	B	STIVERSVILLE	B	SURPRISE	B
SIMMONT	C	SNOWLIN	B	SQUILLCHUCK	B	STOCKBRIDGE	B	SURRENCY	B/D
SIMNER	A	SNOWVILLE	D	SQUIMER	B	STOCKLAND	B	SURVYA	C
SIMON	C	SNOWY	A	SQUIRES	B	STOCKPEN	D	SUSIE CREEK	D
SIMONA	D	SOAKPAK	B	ST. ALBANS	B	STOCKTON	D	SUSITNA	B
SIMOTE	C	SOAP LAKE	B	ST. CHARLES	B	STODICK	D	SUSQUEHANNA	D
SIMPERS	B	SOBOBA	A	ST. CLAIR	D	STOKES	D	SUTHER	C
SIMPSON	C	SOBRANTE	C	ST. ELMO	A	STOMAR	C	SUTHERLIN	C
SIMS	D	SODA LAKE	B	ST. GEORGE	C	STONER	B	SUTLEW	B/C
SINAI	C	SODHOUSE	D	ST. HELENS	A	STONEWALL	A	SUTPHEN	D
SINCLAIR	C	SODUS	C	ST. IGNACE	C	STONO	B/D	SUTTLER	B
SINE	C	SOELBERG	B	ST. JOE	B/D	STONYFORD	D	SUTTON	B
SINGLETREE	C	SOFIA	B	ST. JOHNS	B/D	STOOKEY	B	SVEA	B
SINGSAAS	B	SOGN	D	ST. LUCIE	A	STORDEN	B	SVERDRUP	B
SINNIGAM	C	SOGZIE	B	ST. MARTIN	C	STORLA	B	SVOLD	C
SINOMAX	B	SOKOLOF	B	ST. MARYS	B	STORMITT	B	SWAGER	C
SINTON	B	SOLANO	D	ST. NICHOLAS	D	STORM KING	D	SWAKANE	C
SINUK	D	SOLDATNA	B	ST. PAUL	B	STORY	C	SWAN	C
SION	B	SOLDIER	C	ST. THOMAS	D	STOSSEL	C	SWANBOY	D
SIOUX	A	SOL DUC	B	STAATSBURG		STOUGH	C	SWANNER	D
SIPPLE	A	SOLDUC	B	STABLER	B	STOWELL	D	SWANSON	B
SIRI	B	SOLLEKS	C	STACY	B	STOY	C	SWANTON	B/D
SISKIYOU	B	SOLLER	D	STADY	B	STRAIGHT	C	SWANTOWN	C
SISSETON	B	SOLOMON	D	STAFFORD	C	STRAIN	B	SWAPPS	C
SISSON	B	SOLONA	B	STAGECOACH	B	STRASBURG	C	SWARTSWOOD	C
SITES	C	SOMBRERO	D	STAHL	C	STRATFORD	B	SWARTZ	D

SITKA	B	SOMERS	B	STALEY	C	STRAUSS	C	SWASEY	D
SIXMILE	B	SOMERSET	D	STAMBAUGH	B	STRAW	B	SWASTIKA	C
SIZEMORE	B	SOMERVELL	B	STAMFORD	D	STRAWN	B	SWATARA	A
SIZER	B	SOMSEN	C	STAMPEDE	D	STREATOR	C	SWAUK	C
SKAGGS	B	SONOITA	B	STAN	B	STROLE	B	SWAWILLIA	A
SKAGIT	B/C	SONOMA	D	STANDISH	C/D	STRONGHURST	B	SWEATMAN	C
SKAHA	A	SONTAG	D	STANEY	D	STRONTIA	B	SWEDE	B
SKALAN	C	SOPER	B/C	STANFIELD	C	STROUPE	C	SWEDEN	B
SKAMANIA	B	SOQUEL	B	STANLEY	C	STRYKER	B	SWEEN	C
SKAMOKAWA	B	SORDO	C	STANSBURY	D	STUBBS	C	SWEENEY	B
SKANEE	C	SORF	C	STANTON	D	STUCKCREEK	B	SWEET	C
SKELLOCK	B	SORRENTO	B	STAPLETON	B	STUKEL	D	SWEETGRASS	B
SKERRY	C	SORTER	B/D	STARBUCK	D	STUKEY	B	SWEETWATER	D
SKIDMORE	B	SOSA	C	STARGO	B	STUMBLE	A	SWENODA	B
SKILLET	C	SOTELLA	C	STARICHKOF	D	STUMPP	D	SWIFTCREEK	B
SKINNER	C	SOTIM	B	STARKS	C	STUMP SPRINGS	B	SWIFTON	A
SKIYOU	C	SOUTHFORK	D	STARLEY	D	STUNNER	B	SWIMS	A
SKOKOMISH	B/C	SOUTHGATE	D	STARR	B	STUTTGART	D	SWINGLER	C
SKOOKUMCHUCK	B	SOUTHWICK	C	STASER	B	STUTZMAN	C	SWINK	D
SKUMHEGAN	B	SPAA	D	STATE	B	STUTZVILLE	B/C	SWISOOD	D
SKULL CREEK	D	SPACE CITY	A	STATEN	D	SUBLETTE	B	SWITCHBACK	C
SKUMPAH	D	SPADE	B	STATLER	B	SUDBURY	B	SWITZERLAND	B
SKUTUM	C	SPALDING	D	STAVE	D	SUDDUTH	C	SWOPE	C
SKYBERG	C	SPAN	D	STAYTRON	D	SUFFIELD	C	SWYGERT	C
SKYHAVEN	D	SPANAWAY	B	STEAMBOAT	D	SUGARLOAF	B	SYCAMORE	B/C
SKYKOMISH	B	SPANEL	D	STEARNS	D	SUISUN	D	SYCAN	A
SKYLICK	C	SPARTA	A	STECUM	A	SULA	B	SYLACAUGA	B/D
SKYLINE	D	SPEARFISH	B	STEED	A	SULLY	B	SYLVAN	B
SKYWAY	B	SPEARMAN	C	STEEDMAN	D	SULPHURA	D	SYMERTON	B
SLAB	D	SPEARVILLE	C	STEEKEE	C	SULTAN	B	SYNAREP	B
SLATE CREEK	C	SPECK	D	STEELE	B	SUMAS	B/C	SYRACUSE	B
SLAUGHTER	C	SPECTER	D	STEESE	C	SUMDUM	D	SYRENE	D
SLAVEN	D	SPEELYAI	C	STEFF	C	SUMMA	B	SYRETT	C
SLAWSON	B	SPEIGLE	B	STEGALL	C	SUMMERFIELD	C		
SLAYTON	D	SPENARD	D	STEIGER	A	SUMMERS	B	TABERNASH	B
SLEETH	C	SPENCER	B	STEINAUER	B	SUMMERVILLE	C	TABIONA	B
SLETTEN	D	SPENLO	B	STEINBECK	B	SUMMIT	C	TABLE MOUNTAIN	B
SLICKROCK	B	SPERRY	C	STEINMETZ	D	SUMMITVILLE	B	TABLER	D

SLIGHTS	D	SPICER	C	STEINSBURG	C	SUMTER	C	TABOR	D
SLIGO	B	SPILLVILLE	B	STEIWER	C	SUN	D	TACAN	B
SLIKOK	D	SPINKS	A	STELLAR	C	SUNBURST	C	TACOMA	D
SLIP	B	SPIRES	D	STEMILT	C	SUNBURY	B	TACOOSH	D
SLIPMAN	B/C	SPIRIT	B	STENDAL	C	SUNCOOK	A	TAFT	C
SLOAN	D	SPIRO	B	STEPHEN	C	SUND	C	TAGGERT	C
SLOCUM	B	SPLENDORA	C	STEPHENSBURG	B	SUNDELL	C	TAHOMA	B
SLODUC	C	SPLITRO	D	STEPHENVILLE	B	SUNDERLAND	C/D	TAHQUAMENON	D
SLOSS	C	SPOFFORD	C	STERLING	B	SUNDOWN	B	TAHQUATS	C
SLUICE	B	SPOKANE	B	STERLINGTON	B	SUNFIELD	B	TAINTOR	C
SMARTS	B	SPONSELLER	B	STETSON	B	SUNNILAND	C	TAJO	C
SMITH CREEK	A	SPOON BUTTE	D	STETTER	D	SUNNYHAY	D	TAKEUCHI	C
SMITHDALE	B	SPOONER	C	STEUBEN	B	SUNNYSIDE	B	TAKILMA	B
SMITHNECK	B	SPOTTSWOOD	B	STEVENS	B	SUNNYVALE	C	TAKOTNA	B
SMITHTON	D	SPRAGUE	B/C	STEVENSON	B	SUNRAY	B	TALAG	D
SMOLAN	C	SPRECKELS	C	STEWART	D	SUNRISE	D	TALANTE	C
SMOOT	D	SPRING	C/D	STICKNEY	C	SUNSET	B	TALAPUS	B
SNAG	B	SPRING CREEK	C	STIDHAM	A	SUNSHINE	C	TALBOTT	C
SNAHOPISH	B	SPRINGDALE	B	STIGLER	C	SUNSWEET	C	TALCOT	C
SNAKE	C	SPRINGER	B	STILLMAN	A	SUNUP	D	TALIHINA	D
SNAKE HOLLOW	B	SPRINGERVILLE	D	STILLWATER	D	SUPAN	B	TALKEETNA	C
SNAKELUM	B	SPRINGFIELD	D	STILSON	B	SUPERIOR	C	TALLAC	B
SNEAD	D	SPRINGMEYER	C	STIMSON	B/C	SUPERSTITION	A	TALLADEGA	C
SNELL	C	SPRINGTOWN	C	STINGAL	B	SUPERVISOR	C	TALLAPOOSA	C
SNELLING	B	SPROUL	D	STINSON	C	SUPPLEE	B	TALLEYVILLE	B
SNOHOMISH	D	SPUR	B	STIRK	D	SUR	B	TALLS	B
SNOQUALMIE	B	SPURLOCK	B	STIRUM	B	SURGEM	C	TALLULA	B
TALLY	B	TENINO	B	TIGERON	A	TOMERA	D	TRENTON	D
TALMAGE	A	TENNO	D	TIGIWON	B	TOMICHI	A	TREP	B
TALMO	B	TENORIO	B	TIGRETT		TONOKA	A/D	TRES HERMANOS	B
TALOKA	D	TENOT	C	TIGUA	D	TONASKET	B	TRETTEN	C
TALPA	D	TENRAG	B	TIJERAS	B	TONATA	C	TREVINO	D
TAMA	B	TENSAS	D	TILFORD	B	TONAWANDA	C	TREXLER	C
TAMAHA	C	TENSED	C	TILLEDA	B	TONEY	D	TRIAMI	C
TAMALCO	D	TENSLEEP	B	TILLICUM	B	TONGUE RIVER	C	TRIASSIC	
TAMBA	C/D	TEOCULLI	B	TILLMAN	C	TONINI	B	TRICON	C
TAMELY		TEPEE	D	TILMA	C	TONKA	C	TRIDELL	B
TAMMANY CREEK	B	TEPETE	B/D	TILSIT	C	TONKEY	D	TRIDENT	D

TAMMANY RIDGE	B	TERBIES	C	TILTON	B	TONKIN	C	TRIGO	C
TAMMS	C	TERESA	C	TIMBERG	C	TONKS	B/D	TRIMBLE	B
TAMPICO	B	TERINO	D	TIMBERLY	B	TONOPAH	B	TRIMMER	B
TANAMA	D	TERMINAL	D	TIMBLIN	D	TONOR	C	TRINCHERA	C
				TIMENTWA	B			TRINITY	D
TANBERG	D	TEROUGE	D	TIMKEN	D	TONRA	A	TRIOMAS	B
TANDY	C	TERRA CEIA	A/D	TIMMERMAN	B	TONSINA	B	TRIPIT	C
TANEUM	C	TERRAD	D	TIMMONS	B	TONUCO	C	TRIPLEN	B
TANEY	C	TERRERA	C	TIMPAHUTE	D	TOOLE	D	TRIPOLI	C
TANGAIR	C	TERRETON	C	TIMPANOGOS	B	TOOMES	C	TRIPP	B
TANNA	C	TERRIC	B	TIMPER	D	TOP	C	TRITON	C
TANNER	C	TERRY	B	TIMPOONEKE	B	TOPIA	D	TRIX	B
TANSEM	B	TERWILLIGER	C	TIMULA	B	TOPPENISH	B/C	TROJAN	B
TANTALUS	A	TESAJO	A	TINA	C	TOPTON		TROMMALD	D
TANWAX	D	TESCOTT	C	TINDAHAY	A	TOQUERVILLE	C	TROMP	C
TAOPI	C	TESUQUE	B	TINE	A	TOQUOP	A	TRONSEN	C
TAOS	D	TETON	A	TINGEY	B	TORBOY	B	TROOK	B
TAPIA	C	TETONIA	B	TINSLEY	A	TORCHLIGHT	C	TROPAL	D
TAPPEN	D	TETONKA	C	TINTON	A	TORDIA	D	TROSI	D
TARA	B	TETOTUM	C	TINYTOWN	B	TORHUNTA	C	TROUP	A
TARKIO	D	TEW	B/D	TIOCANO	D	TORNING	B	TROUT CREEK	C
TARKLIN	C	TEX	B	TIOGA	B	TORODA	B	TROUTDALE	B
TARPO	C	TEXLINE	B	TIPPAH	C	TORONTO	C	TROUT LAKE	C
TARRANT	D	TEZUMA	C	TIPPECANOE	B	TORPEDO LAKE	D	TROUT RIVER	A
TARRETE	D	THACKERY	B	TIPPER	A	TORREON	C	TROUTVILLE	B
TARRYALL	B	THADER	C	TIPPERARY	A	TORRES	B	TROXEL	B
TASCOSA	B	THAGE	C	TIPPIPAH	D	TORRINGTON	B	TROY	C
TASSEL	D	THANYON	A	TIPPO	C	TORRO	C	TRUCE	C
TATE	B	THATCHER	B	TIPTON	B	TORSIDO	D	TRUCKEE	C
TATIYEE	C	THATUNA	C	TIPTONVILLE	B	TORTUGAS	D	TRUCKTON	B
TATU	C	THAYNE	B	TIRO	C	TOSTON	D	TRUEFISSURE	A
TATUM	C	THEBES	B	TISBURY	B	TOTELAKE	A	TRUESDALE	C
TAUNTON	C	THEBO	D	TISCH	C	TOTEM	B	TRULL	C
TAVARES	A	THEDALUND	C	TISH TANG	B	TOTTEN	B	TRULON	B
TAWAS	A/D	THENAS	C	TITUSVILLE	C	TOUCHET	B	TRUMAN	B
TAWCAW	C	THEO	C	TIVERTON	A	TOUHEY	B	TRUMBULL	D
TAYLOR	C	THERESA	B	TIVOLI	A	TOULON	B	TRUMP	D
TAYLOR CREEK	D	THERIOT	D	TIVY	C	TOURN	C	TRYON	D

TAYLORSFLAT	D	THERMAL	C	TOA	C	TOURNQUIST	B	TSCHICOMA	B
TAYLORSVILLE	C	THERMOPOLIS	D	TOBICO	D	TOURS	B	TUB	C
TAYSOM	B	THESS	B	TOBIN	B	TOUTLE	A	TUBAC	C
TAZLINA	A	THETFORD	A	TOBISH	C	TOWER	D	TUCANNON	C
TEAL	D	THIEL	A	TOBLER	B	TOWHEE	D	TUCKERMAN	D
TEALSON	C	THIOKOL	C	TOBOSA	D	TOWNER	B	TUCSON	B
TEALWHIT	C	THOENY	D	TOBY	B	TOWNLEY	C	TUCUMCARI	B
TEANAWAY	C	THOMAS	D	TOCCOA	B	TOWNSBURY	B	TUFFIT	D
TEAPO	B	THORNDALE	D	TODD	B	TOWNSEND	C	TUGHILL	D
TEAS	C	THORNDIKE	C/D	TODDLER	B	TOWSON	B	TUJUNGA	A
TEASDALE	B	THORNOCK	D	TODDVILLE	B	TOXAWAY	D	TUKEY	C
TEBO	B	THORNTON	D	TOEHEAD	C	TOY	D	TUKWILA	B
TECHICK	B	THORNWOOD	B	TOEJA	C	TOYAH	B	TULA	C
TECOLOTE	B	THOROUGHFARE	B	TOEM	C	TOZE	B	TULANA	C/D
TECUMSAH	B	THORP	C	TOGO	B	TRABUCO	C	TULARE	C/D
TEDROW	B	THORR	B	TOGUS	D	TRACK	B/C	TULAROSA	B
TEEL	B	THORREL	B	TOHONA	C	TRACY	B	TULIA	B
TEHACHAPI	D	THOW	B	TOINE	C	TRAER	C	TULLAHASSEE	C
TEHAMA	C	THREE MILE	D	TOISNOT	D	TRAIL	A	TULLER	D
TEJA	D	THROCK	C	TOIYABE	C	TRAIL CREEK	B	TULLOCK	B
TEJON	B	THUNDERBIRD	D	TOKEEN	B	TRAM	B	TULLY	C
TEKOA	C	THURBER	C	TOKUL	C	TRANSYLVANIA	B	TULUKSAK	D
TELA	B	THURLONI	C	TOLBY	A	TRAPPER	A	TUMBEZ	D
TELEFONO	C	THURLOW	C	TOLEDO	D	TRAPPIST	C	TUMEY	D
TELEPHONE	D	THURMAN	A	TOLICHA	D	TRAPPS	B	TUMITAS	B
TELFER	A	THURMONT	B	TOLKE	B	TRASK	C	TUMWATER	A
TELFERNER	D	THURSTON	B	TOLL	A	TRAVELERS	D	TUNEHEAN	D
TELIDA	D	TIAGOS	B	TOLLGATE	B	TRAVER	B/C	TUNICA	D
TELL	B	TIAK	C	TOLLHOUSE	D	TRAVESSILLA	D	TUNIS	D
TELLER	B	TIBAN	B	TOLMAN	D	TRAVIS	C	TUNITAS	B
TELLICO	B	TIBBITTS	B	TOLNA	B	TRAWICK	B	TUNKHANNOCK	A
TELLMAN	B	TICA	D	TOLO	B	TRAY	C	TUNNEL	B
TELSTAD	B	TICE	C	TOLSONA	D	TREADWAY	D	TUPELO	D
TEMESCAL	D	TICHIGAN	C	TOLSTOI	D	TREASURE	B	TUPUKNUK	D
TEMPLE	B/C	TICHNOR	D	TOLT	D	TREBLOC	D	TUQUE	B
TEMVIK	B	TICKAPOO	D	TOLTEC	C	TREGO	C	TURBEVILLE	C
TENABO	D	TICKASON	B	TOLUCA	B	TRELONA	D	TURBOTVILLE	C
TENAHA	B	TIDWELL	D	TOLVAR	B	TREMANT	B	TURBYFILL	B

TENAS	C	TIERRA	D	TOMAH	C	TREMBLES	B	TURIN	B
TENCEE	D	TIETON	B	TOMAS	B	TREMPE	A	TURK	D
TENERIFFE	C	TIFFANY	C	TOMAST	C	TREMPEALEAU	B	TURKEYSPRINGS	C
TENEX	A	TIFTON	B	TOME	B	TRENARY	B	TURLEY	C
TENIBAC	B	TIGER CREEK	B	TOMEL	D	TRENT	B	TURLIN	B
TURNBOW	C	USINE	B	VERDUN	D	WADDELL	B	WARDEN	B
TURNER	B	USKA	D	VERGENNES	D	WADDOUPS	B	WARDWELL	C
TURNERVILLE	B	UTALINE	B	VERHALEN	D	WADELL	B	WARE	B
TURNEY	B	UTE	C	VERMEJO	D	WADENA	B	WAREHAM	C
TURRAH	D	UTICA	A	VERNAL	B	WADESBORO	B	WARMAN	D
TURRET	B	UTLEY	B	VERNALIS	B	WADLEIGH	D	WARM SPRINGS	C
TURRIA	C	UTUADO	B	VERNIA	A	WADMALAW	D	WARNERS	A/D
TURSON	B/C	UVADA	D	VERNON	D	WADSWORTH	C	WARREN	
TUSCAN	D	UVALDE	C	VERONA	C	WAGES	B	WARRENTON	B/D
TUSCARAWAS	C	UWALA	B	VESSER	C	WAGNER	D	WARRIOR	
TUSCARORA	C			VESTON	D	WAGRAM	A	WARSAW	B
TUSCOLA	B	VACHERIE	C	VETAL	A	WAHA	C	WARSING	B
TUSCUMBIA	D	VADER	B	VETERAN	B	WAHEE	D	WARWICK	A
TUSEL	C	VADO	B	VEYO	D	WAHIAWA	B	WASATCH	A
TUSKEEGO	C	VAIDEN	D	VIA	B	WAHIKULI	B	WASEPI	B
TUSLER	B	VAILTON	B	VIAN	B	WAHKEENA	B	WASHBURN	
TUSQUITEE	B	VALBY	C	VIBORAS	D	WAHKIACUS	B	WASHINGTON	B
TUSTIN	B	VALCO	C	VIBORG	B	WAHLUKE	B	WASHOE	C
TUSTUMENA	B	VALDEZ	B/C	VICKERY	C	WAHMONIE	D	WASHOUGAL	B
TUTHILL	B	VALE	B	VICKSBURG	B	WAHPETON	C	WASHTENAW	C/D
TUTNI	B	VALENCIA	B	VICTOR	A	WAHTIGUP	C	WASHTENAW	C/D
								WASILLA	D
TUTWILER	B	VALENT	A	VICTORIA	D	WAHTUM	D	WASIOJA	B
TUXEDO		VALENTINE	A	VICTORY	B	WAIAHA	D	WASSAIC	B
TUXEKAN	B	VALERA	C	VICU	D	WAIAKOA	C	WATAB	C
TWIN CREEK	B	VALKARIA	B/D	VIDA	B	WAIALEALE	D	WATAUGA	B
TWINING	C	VALLIAN	D	VIDRINE	C	WAIALUA	B	WATCHAUG	B
TWISP	B	VALLECITOS	C/D	VIEJA	D	WAIAWA	D	WATCHUNG	D
TWO DOT	C	VALLEONO	B	VIENNA	B	WAIHUNA	D	WATERBORO	
TYBO	D	VALLERS	C	VIEQUES	B	WAIKALOA	B	WATERBURY	D
TYEE	D	VALMONT	C	VIEW	C	WAIKANE	B	WATERINO	C
TYGART	D	VALMY	B	VIGAR	C	WAIKAPU	B	WATERS	C
TYLER	D	VALOIS	B	VIGO	D	WAIKOHO	D	WATKINS	B

TYNDALL	B/C	VAMER	D	VIGUS	C	WAILUKU	B	WATKINS RIDGE	B
TYNER	A	VANAJO	D	VIKING	D	WAIMEA	B	WATO	B
TYRONE	C	VANANDA	D	VIL	D	WAINEE	B	WATOPA	B
TYSON	C	VAN BUREN		VILAS	A	WAINOLA	A	WATROUS	B
		VANCE	C	VILLA GROVE	B	WAIPAHU	C	WATSEKA	C
UANA	D	VANDA	D	VILLARS	B	WAISKA	B	WATSON	C
UBAR	C	VANDALIA	C	VILLY	D	WAITS	B	WATSONIA	D
UBLY	B	VANDERDASSON	D	VINA	B	WAKE	D	WATSONVILLE	D
UCOLA	D	VANDERGRIFT	C	VINCENNES	C	WAKEEN	B	WATT	D
UCOLO	C	VANDERHOFF	D	VINCENT	C	WAKEFIELD	B	WATTON	C
UCOPIA	B	VANDERLIP	A	VINEYARD	C	WAKELAND	B/D	WAUBAY	B
UDEL	D	VAN DUSEN	B	VINGO	B	WAKONDA	C	WAUBEEK	B
UDOLPHO	C	VANET	D	VINING	C	WAKULLA	A	WAUBONSIE	B
UFFENS	D	VANG	B	VINITA	C	WALCOTT	B	WAUCHULA	B/D
UGAK	D	VANHORN	B	VINLAND	C	WALDECK	C	WAUCOMA	B
UHLAND	B	VAN NOSTERN	B	VINSAD	C	WALDO	D	WAUCONDA	B
UHLIG	B	VANNOY	B	VINT	B	WALDRON	D	WAUKEE	B
UINTA	B	VANOSS	B	VINTON	B	WALDROUP	D	WAUKEGAN	B
UKIAH	C	VANTAGE	C	VIRA	C	WALES	B	WAUKENA	D
ULEN	B	VAN WAGONER	D	VIRATON	C	WALFORD	C	WAUKON	B
ULLOA	B	VARCO	C	VIRDEN	C	WALKE	C	WAUMBEK	B
ULM	B	VARELUM	C	VIRGIL	B	WALL	B	WAURIKA	D
ULRICHER	B	VARICK	D	VIRGIN PEAK	D	WALLACE	B	WAUSEON	B/D
ULUPALAKUA	B	VARINA	C	VIRGIN RIVER	D	WALLA WALLA	B	WAVERLY	B/D
ULY	B	VARNA	C	VIRTUE	C	WALLER	B/D	WAWAKA	C
ULYSSES	B	VARRO	BV	VISALIA	B	WALLINGTON	C	WAYCUP	B
UMA	A	VARYSBURG	B	VISTA	C	WALLIS	B	WAYDEN	D
UMAPINE	B/C	VASHTI	C	VIVES	B	WALLKILL	C/D	WAYLAND	C/D
UMIAT	D	VASQUEZ	B	VIVI	B	WALLMAN	C	WAYNE	B
UMIKOA	B	VASSALBORO	D	VLASATY	C	WALLOWA	C	WAYNESBORO	B
UMIL	D	VASSAR	B	VOCA	C	WALLPACK	C	WAYSIDE	
UMNAK	B	VASTINE	C	VODERMAIER	B	WALLROCK	B/C	WEA	B
UMPA	B	VAUCLUSE	C	VOLADORA	B	WALLSBURG	D	WEAVER	C
UMPQUA	B	VAUGHNSVILLE	C	VOLCO	D	WALLSON	B	WEBB	C
UNA	D	VAYAS	D	VOLENTE	C	WALPOLE	C	WEBER	B
UNADILLA	B	VEAL	B	VOLGA	D	WALSH	B	WEBSTER	C
UNAWEEP	B	VEAZIE	B	VOLIN	B	WALSHVILLE	D	WEDEKIND	D
UNCOM	B	VEBAR	B	VOLINIA	B	WALTERS	A	WEDERTZ	C

UNCOMPAHGRE	D	VECONT	D	VOLKE	C	WALTON	C	WEDGE	A
UNEEDA	B	VEGA	C	VOLKMAR	B	WALUM	B	WEDOWEE	D
UNGERS	B	VAGA ALTA	C	VOLMER	D	WALVAN	B	WEED	B
UNION	C	VEGA BAJA	C	VOLNEY	B	WAMBA	B/C	WEEDING	A/C
UNIONTOWN	B	VEKOL	D	VOLPERIE	C	WAMIC	B	WEEDMARK	B
UNIONVILLE	C	VELDA	B	VOLTAIRE	D	WAMPSVILLE	B	WEEKSVILLE	B/D
UNISUN	C	VELMA	B	VOLUSIA	C	WANATAH	B	WEEPON	D
UPDIKE	D	VELVA	B	VONA	B	WANBLEE	D	WEHADKEE	D
UPSAL	C	VENA	C	VORE	B	WANDO	A	WEIKERT	C/D
UPSATA	A	VENANGO	C	VROOMAN	B	WANETTA	A	WEIMER	D
UPSHUR	C	VENATOR	D	VULCAN	C	WANILLA	C	WEINBACH	C
UPTON	C	VENETA	C	VYLACH	D	WANN	A	WEIR	D
URACCA	B	VENEZIA	D			WAPAL	B	WEIRMAN	B
URBANA	C	VENICE	D	WABANICA	D	WAPATO	C/D	WEISER	C
URBO	D	VENLO	D	WABASH	D	WAPELLO	B	WEISHAUPT	D
URICH	D	VENUS	B	WABASHA	D	WAPINITIA	B	WEISS	A
URNE	B	VERBOORT	D	WABASSA	B/D	WAPPING	B	WEITCHPEC	B
URSINE	D	VERDE	C	WABEK	B	WAPSIE	B	WELAKA	A
URTAH	C	VERDEL	D	WACA	C	WARBA	B	WELBY	B
URWIL	D	VERDELLA	D	WACOTA	B	WARD	D	WELCH	C
USAL	B	VERDICO	D	WACOUSTA	C	WARDBORO	A	WELD	C
USHAR	B	VERDIGRIS	B	WADAMS	B	WARDELL	D	WELDA	C
WELDON	D	WICKIUP	C	WISNER	D	YALMER	B		
WELDONA	B	WICKLIFFE	D	WITBECK	D	YAMAC	B		
WELLER	C	WICKSBURG	B	WITCH	D	YAMHILL	C		
WELLINGTON	D	WIDTSOE	C	WITHAM	D	YAMPA	C		
WELLMAN	B	WIEHL	C	WITHEE	C	YAMSAY	D		
WELLNER	B	WIEN	D	WITT	B	YANA	B		
WELLSBORO	C	WIGGLETON	B	WITZEL	D	YANCY	C		
WELLSTON	B	WIGTON	A	WODEN	B	YARDLEY	C		
WELLSVILLE	B	WILBRAHAM	C	WODSKOW	B/C	YATES	D		
WELRING	D	WILBUR	C	WOLCOTTSBURG		YAUCO	C		
WEMPLE	B	WILCO	C	WOLDALF	C/D	YAWDIM	D		
WENAS	B/C	WILCOX	D	WOLF	B	YAWKEY	C		
WENATCHEE	C	WILCOXSON	C	WOLFESEN	C	YAXON	B		
WENDEL	B/C	WILDCAT	D	WOLFESON	C	YEARY	C		
WENHAM		WILDER	B	WOLFORD	B	YEATES HOLLOW	C		
WENONA	C	WILDERNESS	C	WOLF POINT	D	YEGEN	B		

WENTWORTH	B	WILDROSE	D	WOLFTEVER	C	YELM	B
WERLOW	C	WILDWOOD	D	WOLVERINE	A	YENRAB	A
WERNER	B	WILEY	C	WOODBINE	B	YEOMAN	B
WESO	C	WILKES	C	WOODBRIDGE	C	YESUM	B
WESSEL	B	WILKESON	C	WOODBURN	C	YETULL	A
WESTBROOK	D	WILKINS	D	WOODBURY	D	YODER	B
WESTBURY	C	WILL	D	WOODCOCK	B	YOKOHL	D
WESTCREEK	B	WILLACY	B	WOODENVILLE	C	YOLLABOLLY	D
WESTERVILLE	C	WILLAKENZIE	C	WOODGLEN	D	YOLO	B
WESTFALL	C	WILLAMAR	D	WOODHALL	B	YOLOGO	D
WESTFIELD		WILLAMETTE	B	WOODHURST	A	YOMBA	C
WESTFORD		WILLAPA	C	WODDINVILLE	C/D	YOMONT	B
WESTLAND	B/D	WILLARD	B	WOODLY	B	YONCALLA	C
WESTMINSTER	C/D	WILLETTE	A/D	WOODLYN	C/D	YONGES	D
WESTMORE	B	WILLHAND	B	WOODMANSIE	B	YONNA	B/D
WESTMORELAND	B	WILLIAMS	B	WOODMERE	B	YORDY	B
WESTON	D	WILLIAMSBURC	B	WOOD RIVER	D	YORK	C
WESTPHALIA	B	WILLIAMSON	C	WOODROCK	C	YORKVILLE	D
WESTPLAIN	C	WILLIS	C	WOODROW	C	YOST	C
WESTPORT	A	WILLITS	B	WOODSCROSS	D	YOUGA	B
WESTVILLE	B	WILLOUGHBY	B	WOODSFIELD	C	YOUMAN	C
WETHERSFIELD	C	WILLOW CREEK	B	WOODSIDE	A	YOUNGSTON	B
WETHEY	B/C	WILLOWDALE	B	WOODSON	D	YOURAME	A
WETTERHORN	C	WILLOWS	D	WOODSTOCK	C/D	YOVIMPA	D
WETZEL	D	WILLWOOD	A	WOODSTOWN	C	YSIDORA	D
WEYMOUTH	B	WILMER	C	WOODWARD	B	YTRURBIDE	A
WHAKANA	B	WILPAR	D	WOOLMAN	B	YUBA	D
WHALAN	B	WILSON	D	WOOLPER	C	YUKO	C
WHARTON	C	WILTSHIRE	C	WOOLSEY	C	YUKON	D
WHATCOM	C	WINANS	B/C	WOOSLEY	C	YUNES	D
WHATELY	D	WINBERRY	D	WOOSTER	C	YUNQUE	C
WHEATLEY	D	WINCHESTER	A	WOOSTERN	B		
WHEATRIDGE	C	WINCHUCK	C	WOOTEN	A	ZAAR	D
WHEATVILLE	B	WINDER	B/D	WORCESTER	B	ZACA	D
WHEELER	B	WINDHAM	B	WORF	D	ZACHARIAS	B
WHEELING	B	WINDMILL	B	WORK	C	ZACHARY	D
WHEELON	D	WINDOM	B	WORLAND	B	ZAFRA	B
WHELCHEL	B	WIND RIVER	B	WORLEY	C	ZAHILL	B

WHETSTONE	B
WHIDBEY	C
WHIPPANY	C
WHIPSTOCK	C
WHIRLO	B
WHIT	B
WHITAKER	C
WHITCOMB	C
WHITE BIRD	C
WHITECAP	D
WHITEFISH	B
WHITEFORD	B
WHITEHORSE	B
WHITE HOUSE	C
WHITELAKE	B
WHITELAW	B
WHITEMAN	D
WHITEROCK	D
WHITESBURG	C
WHITE STORE	D
WHITE SWAN	C
WHITEWATER	B
WHITEWOOD	C
WHITLEY	B
WHITLOCK	B
WHITMAN	D
WHITNEY	B
WHITORE	A
WHITSOL	B
WHITSON	D
WHITWELL	C
WHOLAN	C
WIBAUX	C
WICHITA	C
WICHUP	D
WICKERSHAM	B
WICKETT	C
WICKHAM	B
WINDSOR	A
WINDTHORST	C
WINDY	C
WINEG	C
WINEMA	C
WINETTI	B
WINFIELD	C
WING	D
WINGATE	B
WINGER	C
WINGVILLE	B/D
WINIFRED	C
WINK	B
WINKEL	D
WINKLEMAN	C
WINKLER	A
WINLO	D
WINLOCK	C
WINN	C
WINNEBAGO	B
WINNEMUCCA	B
WINNESHIEK	B
WINNETT	D
WINONA	D
WINOOSKI	B
WINSTON	A
WINTERS	C
WINTERSBURG	C
WINTERSET	C
WINTHROP	A
WINTONER	C
WINU	C
WINZ	C
WIOTA	B
WISHARD	A
WISHEYLU	C
WISHKAH	C
WISKAH	C
WORMSER	C
WOROCK	B
WORSHAM	D
WORTH	C
WORTHEN	B
WORTHING	D
WORTHINGTON	C
WORTMAN	C
WRENTHAM	C
WRIGHT	C
WRIGHTMAN	C
WRIGHTSVILLE	D
WUNJEY	B
WURTSBORO	C
WYALUSING	D
WYARD	B
WYARNO	B
WYATT	C
WYEAST	C
WYEVILLE	C
SYGANT	C
WYKOFF	B
WYMAN	B
WYMORE	C
WYNN	B
WYNOOSE	D
WYO	B
WYOCENA	B
XAVIER	B
YACOLT	B
YAHARA	B
YAHOLA	B
YAKI	D
YAKIMA	B
YAKUS	D
YALLANI	B
ZAHL	B
ZALESKI	C
ZALLA	A
ZAMORA	B
ZANE	C
ZANEIS	B
ZANESVILLE	C
ZANONE	C
ZAPATA	C
ZAVALA	B
ZAVCO	C
ZEB	B
ZEESIX	C
ZELL	B
ZEN	C
ZENDA	C
ZENIA	B
ZENIFF	B
ZEONA	A
ZIEGLER	C
ZIGWEID	B
ZILLAH	B/C
ZIM	D
ZIMMERMAN	A
ZING	C
ZINZER	B
ZION	C
ZIPP	C/D
ZITA	B
ZOAR	C
ZOATE	D
ZOHNER	B/D
ZOOK	C
ZORRAVISTA	A
ZUFELT	B/D
ZUKAN	D
ZUMBRO	B
ZUMWALT	C
ZUNDELL	B/C
ZUNHALL	B/C
ZUNI	D
ZURICH	B
ZWINGLE	D

NOTES: A BLANK HYDROLOGIC SOIL GROUP INDICATES THE SOIL GROUP HAS NOT BEEN DETERMINED.
TWO SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.

APPENDIX C:

EXAMPLE DATA SETS

```
EXAMPLE DATA SET LONG ISLAND, N.Y. ALDICARB PESTICIDE ON POTATOES
  010177          123179
----------------  HYDROLOGY PARAMETERS  --------------------
    0.70    0.45       1    15.0       1       3
    9.55   10.53   11.77   13.07   14.16   14.72   14.44   13.48
   12.23   10.95    9.81    9.21
       0
       1
       1     0.0    30.0    40.0       3 77 67 72
       3
  100577  220877  100977       1
  100578  220878  100978       1
  100579  220879  100979
----------------  PESTICIDE PROPERTIES  ---------------------
       6
  150477    2.24     1.0
  100677    1.35     1.0
  150478    2.52     1.0
  100678    2.02     1.0
  150479    3.19     1.0
  100679    2.52     1.0
       0
----------------  SOIL PROPERTIES       ----------------------
   225.0     1.0      45       0       0       0       0
       2
       1    30.0    1.62     0.0  0.0139    0.24
            0.24    0.10    0.14
       2   195.0    1.62     0.0  0.0009    0.24
            0.24    0.10    0.07
       0       0
    WATR    MNTH       1    PEST    MNTH       1    CONC    MNTH        1
       0
```

```
EXAMPLE DATA SET WATKINSVILLE, GEORGIA  ATRAZINE PESTICIDE ON CORN
   010174  123174
-------------------  HYDROLOGY PARAMETERS  ---------------------
    0.80    0.45       0    10.0       1       1
       1
    0.28    0.28     1.0    1.00     2.8
       1
       1    0.25    60.0    90.0    0.00       3 86 78 82 .50 .20 .20
       1
  290474  160974  291074
-------------------  PESTICIDE PARAMETERS  ----------------------
       1
  110574    3.80    0.0
       0
-------------------  SOIL PARAMETERS       -----------------------
   175.0     0.1      35       0       0       0       1
       3
       1    10.0     1.6     0.0   0.037   0.242    2.20
           0.242   0.145    2.24
       2    50.0     1.6     0.0   0.037   0.242    2.20
           0.245   0.145    2.24
       3   115.0     1.6     0.0   0.037   0.242    2.20
           0.242   0.145    2.24
       1       1
  0.0016  0.0017  0.0018  0.0019  0.0019  0.0018  0.0017  0.0016
  0.0016  0.0016  0.0016  0.0016  0.0015  0.0013  0.0010  0.0007
  0.0004  0.0001  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  0.0000  0.0000  0.0000
    WATR    YEAR       1    PEST    MNTH       1
       1
    TPST    TCUM      13    1.E5
```

EXAMPLE OUTPUT (HYDROLOGY FILE) WATKINSVILLE DATA SET

```
********************************
*  PESTICIDE ROOT ZONE MODEL   *
*     VERSION 1  (PRZM)        *
*                              *
*     1 MAR., 1984             *
*                              *
********************************

DEVELOPED BY:
      U.S. ENVIORONMENTAL PROTECTION AGENCY
      OFFICE OF RESEARCH AND DEVELOPMENT
      ATHENS ENVRIONMENTAL RESEARCH LABORATORY
      ATHENS, GA.  30613
      404-546-3138
  AND
      ANDERSON-NICHOLS
      2666 EAST BAYSHORE ROAD
      PALO ALTO, CA.  94303
      415-493-1864

THIS RUN WAS MADE AT **  11:30:58  ON  01-APR-84  **

EXAMPLE DATA SET WATKINSVILLE, GEORGIA  ATRAZINE ON CORN



SIMULATION START DATE  (DAY-MONTH-YEAR)           19 APR., 74
SIMULATION  END  DATE  (DAY-MONTH-YEAR)           31 DEC., 74


****************  HYDROLOGY PARAMETERS  ******************


HYDROLOGY AND SEDIMENT RELATED PARAMETERS
- - - - - - - - - - - - - - - - - - - - -

PAN COEFFICIENT FOR EVAPORATION                      0.8000
FLAG FOR ET SOURCE (0=EVAP,1=TMEP,2=EITHER)               0
DEPTH TO WHICH ET IS COMPUTED YEAR-ROUND (CM)          10.00
SNOW MELT COEFFICIENT (CM/DEG-C-DAY)                 0.4570
INITIAL CROP NUMBER                                       1
INITIAL CROP CONDITION                                    1

SOIL EROSION PARAMETERS
- - - - - - - - - - - -

USLE "K"  PARAMETER                                  0.2800
USLE "LS" PARAMETER                                  0.2800
USLE "P"  PARAMETER                                   1.000
FIELD OR PLOT AREA (HA)                               1.000
AVERAGE EROSIVE STORM DURATION                        2.800
```

```
CROP_INFORMATION
- - - - - - - - -

       MAXIMUM    MAXIMUM                             SURFACE
CROP   INTERCEPT  ACTIVE      MAXIMUM  MAXIMUM        CONDITION
NUMBER POTENTIAL  ROOT DEPTH  COVER    WEIGHT         AFTER        AMC  RUNOFF CURVE
         (CM)       (CM)       (90%)   (KG/M**2)      HARVEST           FALLOW CROP

                                                                     I      72    60
   1     0.2500     60.00     90.00    0.0000              3        II      86    78
                                                                   III      94    90

        NUMBER   USLEC COVER MANAGEMENT
        RESIDUE  "C" FACTOR
                 FALLOW  CROP    RESIDUE
             66
             82  0.5000  0.2000  0.2000
             92


CROP ROTATION INFORMATION
- - - - - - - - - - - - -

CROP                 EMERGENCE            MATURATION            HARVEST
NUMBER               DATE                 DATE                  DATE

   1                 29 APR., 74          16 SEPT., 74          29 OCT., 74

***************** PESTICIDE PROPERTIES  *******************


PESTICIDE APPLICATION INFORMATION
- - - - - - - - - - - - - - - - -

                    PESTICIDE             INCORPORATION
APPLICATION         APPLIED               DEPTH
DATE                (KG/HA)               (CM)

11 MAY , 74          3.800                0.000

PLANT PESTICIDE PARAMETERS
- - - - - - - - - - - - -

MODEL UTILIZED (1=SOIL,2=LINEAR,3=EXPONENTIAL)             1
```

```
*****************    SOIL PARAMETERS    ******************


GENERAL SOIL_INFORMATION
- - - - - - - - - - - -


CORE DEPTH (CM)                                          175.0
TOTAL HORIZONS IN CORE                                       3
TOTAL COMPARTMENTS IN CORE                                  35
PLANT UPTAKE EFFICIENCY FACTOR                          0.1000E-01
THETA FLAG                 (0=INPUT,1=CALUCLATED)            0
PARTITION COEFFICIENT FLAGE (0=INPUT,1=CALCULATED)           0
BULK DENSITY FLAG          (0=INPUT,1=CALCULATED)            0
SOIL HYDRAULICS MODULE     (0=HYDR1,1=HYDR2)                 1

SOIL_HORIZON_INFORMATION
- - - - - - - - - - - -
                                         INITIAL            FIELD    WILTING
                               PESTICIDE SOIL               CAPACITY POINT
                     BULK      DECAY     WATER   DRAINAGE   WATER    WATER
         THICKNESS   DENSITY   RATE      CONTENT PARAMETER  CONTENT  CONTENT
HORIZON  (CM)        (G/CM**3) (/DAY)    (CM/CM) (/DAY)     (CM/CM)  (CM/CM)

   1      10.00      1.600   0.3700E-01  0.2420  2.200      0.2420   0.1450
   2      50.00      1.600   0.3700E-01  0.2420  2.200      0.2420   0.1450
   3     115.00      1.600   0.3700E-01  0.2420  2.200      0.2420   0.1450

         PARTITION   DISPERSION   ORGANIC
         COEFFICIENT COEFFICIENT  CARBON
         (CM**2/G)   (CM**2/DAY)   (%)

         2.240        0.0000
         2.240        0.0000
         2.240        0.0000


OUTPUT_FILE PARAMETERS
- - - - - - - - - - -

OUTPUT    TIME STEP      LAYER FREQ

  WATR      YEAR             1
  PEST      MNTH             5


PLOT_FILE INFORMATION
- - - - - - - - - - -

NUMBER OF PLOTTING VARIABLES           1

TIMSER NAME        MODE                ARGUMENT        CONSTANT

TPST               TCUM                   13            1.000
```

```
************************
* ANNUAL WATER OUTPUT  *
*                      *
* DATE:     31 DEC., 74*
************************
                          ALL HYDROLOGY UNITS ARE CM OF WATER
                          SEDIMENT UNITS ARE METRIC TONNES
                          NUMBERS IN PARENTHESES ARE SOIL WATER CONTENTS
CURRENT CONDITIONS
------- ----------

CROP NUMBER                              1
FRACTION OF GROUND COVER            0.0000
INTERCEPTION POTENTIAL              0.0000
DEPTH TO WHICH ET IS EXTRACTED(CM)  10.00

FLUXES AND STORAGES FOR THIS PERIOD
------ --- -------- --- ---- ------

                   PREVIOUS
                   STORAGE     PRECIPITA-  EVAPORA-   HRUFALL   CURRENT
                                 TION       TION                STORAGE
CANOPY             0.0000      74.40       3.446      0.95      0.0000

                  THRU FALL    RUNOFF      INFIL-
                                           TRATION

SURFACE           70.95        14.45       56.33

SOIL     COMPART-
LAYERS   COMPART- PREVIOUS     LEACHING    TRANSPIRA- LEACHING  CURRENT
HORIZON  MENTS    STORAGE      INPUT        TION      OUTPUT    STORAGE
-------  -----    -------      -----        ----      ------    -------

   1        1     1.210 (.242) 56.50       20.67      38.10    1.206 (.241)
   1        2     1.210 (.242) 35.83       8.527      29.04    1.212 (.242)

   2        3     1.210 (.242) 27.28       3.534      23.35    1.215 (.243)
   2        4     1.210 (.242) 23.71       2.845      19.12    1.218 (.244)
   2        5     1.210 (.242) 20.80       2.047      16.16    1.221 (.244)
   2        6     1.210 (.242) 18.09       1.491      14.68    1.223 (.245)
   2        7     1.210 (.242) 17.12       0.9849     13.64    1.225 (.245)
   2        8     1.210 (.242) 16.05       0.5887     13.03    1.227 (.245)
   2        9     1.210 (.242) 15.37       0.4715     12.55    1.229 (.246)
   2       10     1.210 (.242) 14.81       0.3778     12.15    1.229 (.246)
   2       11     1.210 (.242) 14.34       0.2747     11.85    1.229 (.246)
   2       12     1.210 (.242) 13.98       0.1504     11.68    1.229 (.246)

   3       13     1.210 (.242) 13.75       0.0000     11.66    1.229 (.246)
   3       14     1.210 (.242) 13.67       0.0000     11.64    1.229 (.246)
   3       15     1.210 (.242) 13.60       0.0000     11.63    1.229 (.246)
   3       16     1.210 (.242) 13.54       0.0000     11.61    1.229 (.246)
   3       17     1.210 (.242) 13.48       0.0000     11.59    1.229 (.246)
   3       18     1.210 (.242) 13.43       0.0000     11.57    1.229 (.246)
```

```
3       19        1.210 (.242) 11.57     0.0000      11.55    1.228 (.246)
3       20        1.210 (.242) 11.55     0.0000      11.54    1.228 (.245)
3       21        1.210 (.242) 11.54     0.0000      11.52    1.227 (.245)
3       22        1.210 (.242) 11.52     0.0000      11.50    1.227 (.245)
3       23        1.210 (.242) 11.50     0.0000      11.48    1.227 (.245)
3       24        1.210 (.242) 11.48     0.0000      11.47    1.226 (.245)
3       25        1.210 (.242) 11.47     0.0000      11.45    1.226 (.245)
3       26        1.210 (.242) 11.45     0.0000      11.44    1.226 (.245)
3       27        1.210 (.242) 11.44     0.0000      11.42    1.226 (.245)
3       28        1.210 (.242) 11.42     0.0000      11.41    1.225 (.245)
3       29        1.210 (.242) 11.41     0.0000      11.39    1.225 (.245)
3       30        1.210 (.242) 11.39     0.0000      11.38    1.225 (.245)
3       31        1.210 (.242) 11.38     0.0000      11.36    1.224 (.245)
3       32        1.210 (.242) 11.36     0.0000      11.35    1.224 (.245)
3       33        1.210 (.242) 11.35     0.0000      11.33    1.224 (.245)
3       34        1.210 (.242) 11.33     0.0000      11.32    1.223 (.245)
3       35        1.210 (.242) 11.32     0.0000      11.31    1.223 (.245)


SUMMARY FLUXES

TOTAL SEDIMENT ERODED FROM SURFACE        3.383
TOTAL ET FROM PROFILE                     41.96
RECHARGE BELOW ROOT ZONE                  13.75

MATERIAL BALANCE

WATER BALANCE ERROR                      -.1103E-05
CUMULATIVE ERROR                         -.3838E-04
```

APENDIX D:

JULIAN DAY CALENDAR (PERPETUAL)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

APPENDIX E:

PROGRAMMER'S GUIDE

PROGRAM STRUCTURE

PRZM is structured so that a single main routine calls every subroutine in sequence with one exception. The flow chart provided in Figure E-1 shows the order of the call sequence, read from left to right and top to bottom. Only the tridiagonal matrix solving subroutine is not called directly by the main program. Some subroutines (THCALC, KDCALC, EROSN, and all output routines) may not be called in every circumstance depending on user input requirements or specific simulation requirements (EROSN, PESTAP). Either of the soil hydraulics routines, HYDR1 or HYDR2, may be called, depending on the choice made in the input sequence. All values passing in and out of subroutines are handled through COMMON blocks exept those passed between SLPEST and TRDIAG. The flow chart provides a brief description of the function of each routine.

Numerous comment lines in the code itself provide more detailed description of functions performed by each subroutine.

COMMON BLOCKS

PRZM uses few subroutine arguments and passes most information through six COMMON blocks. Each block contains related parameters, fluxes, and state variables. The COMMON blocks may be stored as files separate from the PRZM code, and accessed by use of INCLUDE statements at the beginning of the main program and each subroutine. Only the COMMON blocks necessary for the execution of a subroutine are included in the subroutine. The six COMMON blocks are:

1) HYDR - surface and soil hydrology related terms
2) PEST - pesticide fate, transport, and application related terms
3) CROP - crop timing and growth related terms
4) MET - meteorologic related terms
5) MISC - miscellaneous terms including output flags and time-keeping variables

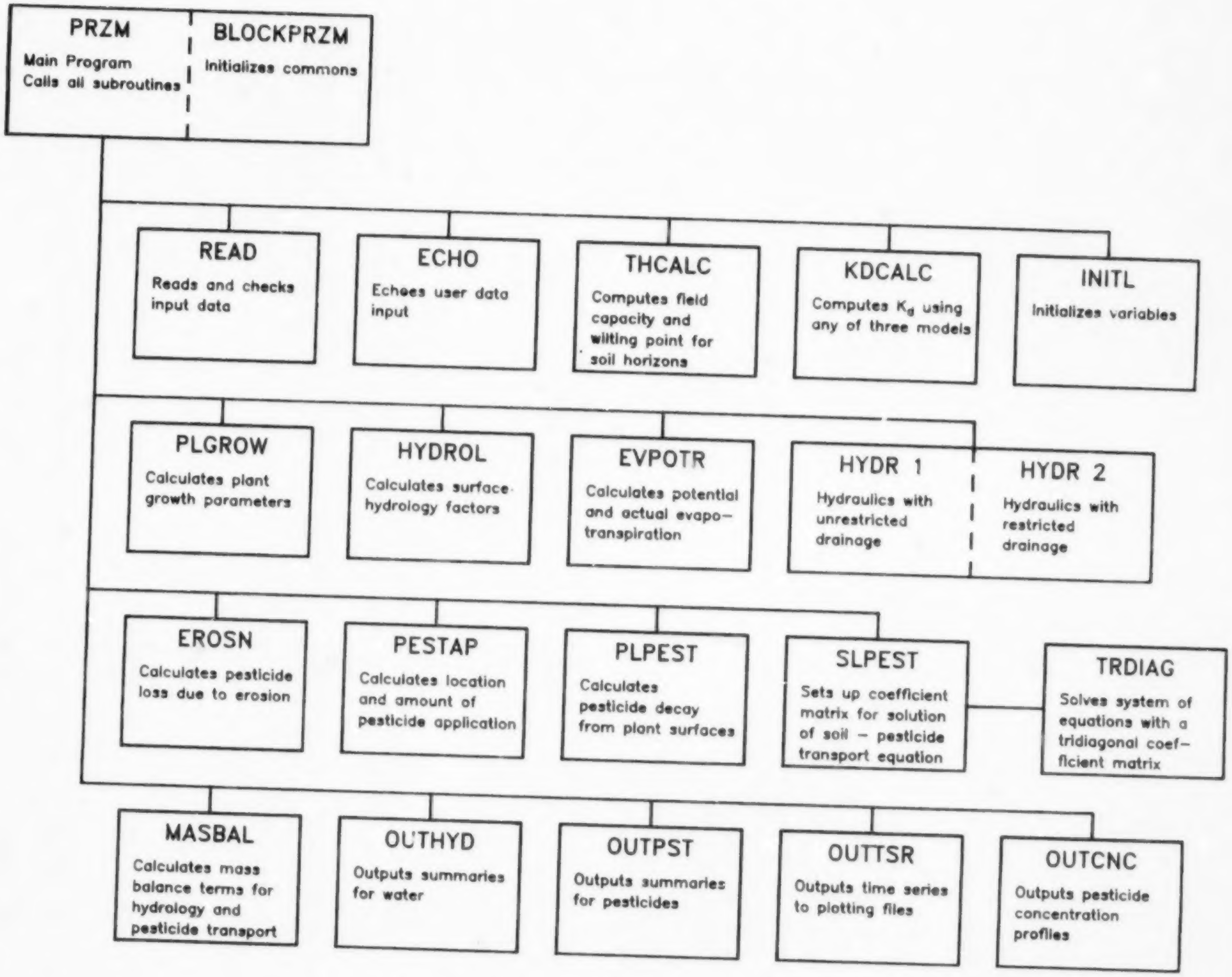
PRZM
Main Program
Calls all subroutines
BLOCKPRZM
Initializes commons
READ
Reads and checks input data
ECHO
Echoes user data input
THCALC
Computes field capacity and wilting point for soil horizons
KDCALC
Computes K_d using any of three models
INITL
Initializes variables
PLGROW
Calculates plant growth parameters
HYDROL
Calculates surface hydrology factors
EVPOTR
Calculates potential and actual evapo-transpiration
HYDR 1
Hydraulics with unrestricted drainage
HYDR 2
Hydraulics with restricted drainage
EROSN
Calculates pesticide loss due to erosion
PESTAP
Calculates location and amount of pesticide application
PLPEST
Calculates pesticide decay from plant surfaces
SLPEST
Sets up coefficient matrix for solution of soil – pesticide transport equation
TRDIAG
Solves system of equations with a tridiagonal coef-ficient matrix
MASBAL
Calculates mass balance terms for hydrology and pesticide transport
OUTHYD
Outputs summaries for water
OUTPST
Outputs summaries for pesticides
OUTTSR
Outputs time series to plotting files
OUTCNC
Outputs pesticide concentration profiles

Figure E-1. PRZM subroutine structure.

6) ACCUM - cumulative terms carried from one time step to the next, primarily for outputting water and pesticide summaries.

A complete list of all the model variables and parameters are contained in Table E-1. The table gives (from left to right) variable name, internal unit, (which may differ from the user input units for some input variables), a variable description, a list of each subroutine in which it appears, the COMMON block in which it appears and whether it is an input (I), output (O), modified (M) or local (blank) variable.

PARAMETER STATEMENTS

Use of two PARAMETER statements in PRZM precludes the need for most users to access the body of the model to make changes. The user need only edit the PARAMETER statements and recompile the code to meet most system requirements.

Array Sizes

The first PARAMETER statement used at the beginning of each subroutine enables the user to easily change sizes of the most commonly utilized arrays. Most of the arrays in PRZM are dimensioned by 1 of 3 parameters. These are the number of compartments in the soil profile (NCMPTS), the number of pesticide applications (NAPP), and the number of different cropping periods (NC). By changing their values in the PARAMETER statement, all of the arrays associated with these arguments in PRZM will automatically reflect those changes. The PARAMETER statements can be stored in files separate from the PRZM code. They are included at the beginning of each subroutine by use of an INCLUDE statement. If INCLUDE statements are not used, then the PARAMETER statement at the beginning of each subroutine must be edited to avoid disrupting COMMON memory areas, if changes are desired in COMMON array sizes. Chapter 4 suggests values for NCMPTS to both minimize computer run-time and the effects of numerical dispersion. The values of NCMPTS and NAPP must be at least one number larger than the number of compartments and pesticide applications to be simulated. Values for NC and NAPP will depend on the system simulated. Even using small values of these array dimensions, smaller computers may require overlays or segmentation in order to fit the program on a particular machine.

File Units

The second PARAMETER statement used at the beginning of each subroutine defines the logical unit numbers associated with input and output files. Different machines have different requirements as to logical unit specification. By equating the file unit number variable to the machine specific number system in the PARAMETER statement, all occurrences of READ and WRITE statements can be changed. The parameter list contains the parameters FLMT, FLIN, FLWT, FLPS, FLTS and FLCN. Numbers supplied for these parame-

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation

Variable	Units	Type	Description	Subroutine	Common	I,M,O
A	day^{-1}	Array	Lower Diagonal Element of Solution Matrix (I-1)	SLPEST	PEST	O
				TRDIAG		I
AD	day^{-1}	Array	Soil Horizon Drainage Parameter	READ	HYDR	O
				ECHO		I
				INITL		I
				HYDR2		I
ADFLUX	$g\ cm^{-2}\ day^{-1}$	Array	Advective Flux of Pesticide	SLPEST	PEST	O
				MASBAL		I
				OUTPST		I
				OUTTSR		I
ADS	$mg\ kg^{-1}$	Array	Adsorbed Portion of Pesticide in Each Compartment	OUTCNC		
AFIELD	ha	Scalar	Area of Field	READ	HYDR	O
				EROSN		
AINF	cm	Array	Percolation Into Each Soil Compartment	HYDROL	HYDR	O
				HYDR1		I
				HYDR2		I
AMXDR	cm	Scalar	Maximum Rooting Depth of Each Crop	READ	CROP	O
				INITL		I
				PLGROW		I
ANETD	cm	Scalar	Minimum Depth From Which ET is Extracted Year Around	READ	CROP	O
				INITL		I
ANUM	cm	Scalar	Total Available Water in Profile	EVPOTR		
APD	-	Scalar	Day of Month of Pesticide Application	READ		
APM	-	Scalar	Month of Pesticide Application	READ		
AVSTOR	$cm^3\ cm^{-3}$	Scalar	Available Water Storage	HYDR2		
AW	-	Scalar	Fraction of Soil Voids Occupied by Water	EVPOTR		
B	day^{-1}	Array	Diagonal Element of Solution Matrix (I)	SLPEST	PEST	O
				TRDIAG		
BD	$g\ cm^{-3}$	Array	Whole Soil or Mineral Soil Bulk Density (Either is Entered)	READ	HYDR	O
				ECHO		I
				INITL		M
				THCALC		I
				PESTAP		I
				MASBAL		I
				OUTPST		I
				OUTTSR		I
				OUTTSR		I
				OUTCNC		I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
BDFLAG	-	Scalar	Bulk Density Flag (0= Whole Soil BD Entered, 1= Mineral BD and OC Entered)	READ ECHO INITL		O I I
C	day^{-1}	Array	Upper Diagonal Element of Solution Matrix (I+1)	SLPEST TRDIAG	PEST	O I
CB	kg ha^{-1}	Scalar	Cumulative Pesticide Balance Error	OUTPST		
CEVAP	cm	Scalar	Current Daily Canopy Evaporation Depth	EVPOTR MASBAL OUTHYD OUTTSR	HYDR	O I I I
CFLAG	-	Scalar	Conversion Flag for Initial Pesticide Input	READ INITL	MISC	O I
CINT	cm	Scalar	Current Crop Interception Storage	INITL HYDROL EVPOTR MASBAL OUTHYD OUTTSR	HYDR	O I I I I I
CINTB	cm	Scalar	Crop Interception From Previous Time Step	PMAIN MASBAL OUTHYD	HYDR	O I I
CINTCP	cm	Array	Maximum Interception Storage of Each Crop	READ ECHO PLGROW	CROP	O I I
CLAY	percent	Array	Percent Clay in the Soil Horizon	READ ECHO INITL THCALC	HYDR	O I I I
CN	-	Array	Runoff Curve Numbers for Antecedent Soil Moisture Condition II	READ ECHO HYDROL	HYDR	O I I
CNDM	-	Array	Accumulated Number of Days in Each Month (With and w/o Leap Year)	PMAIN		
CNDMO	-	Array	Accumulated Number of Days in Each Month (With and w/o Leap Year)	PMAIN READ ECHO INITL OUTHYD OUTPST	MISC	O I I I I I
CONC	-	Alpha-numeric	Flag for Output of Soil Pesticide Concentration Profile	PMAIN		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
CONST	-	Scalar	Constant Values Used to Multiply Each Time Series Output	READ		O
				ECHO		I
				OUTTSR		I
CORED	cm	Scalar	Total Depth of Soil Profile	READ	HYDR	O
				ECHO		I
				INITL		I
COVER	fraction	Scalar	Current Areal Cover of Crop Canopy	PLGROW	CROP	O
				PESTAP		I
				OUTHYD		I
COVMAX	fraction	Array	Maximum Areal Coverage of Each Crop at Full Canopy Development	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
CPBAL	$g\ cm^{-2}$	Scalar	Cumulative Pesticide Balance Error	MASBAL	PEST	M
				OUTPST		I
CURVN	-	Scalar	Current Value of Runoff Curve Number	HYDROL		
CWBAL	cm	Scalar	Cummulative Water Balance Error	MASBAL	HYDR	M
				OUTHYD		I
DAY	-	Alpha-numeric	Flag for Daily Output of Water or Pesticide Summary	PMAIN		
DELT	day	Scalar	Time Step	INITL	MISC	O
				HYDR2		I
				PLPEST		I
				SLPEST		I
				MASBAL		I
DELX	cm	Scalar	Compartment Thickness	INITL	HYDR	O
				PLGROW		I
				HYDROL		I
				HYDR1		I
				HYDR2		I
				EROSN		I
				PESTAP		I
				SLPEST		I
				MASBAL		I
				OUTHYD		I
				OUTPST		I
				OUTTSR		I
DELXSQ	cm^{-2}	Scalar	Compartment Thickness Squared	INITL	HKYDR	O
				SLPEST		
DENOM	cm	Scalar	Total Voids in the Soil Profile	EVPOTR		
DENOM	$cm\ hr^{-1}$	Scalar	Available Water for Run-off During a Storm	EROSN		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
DEPI	cm	Array	Depth of Pesticide	READ	PEST	O
			Incorporation	ECHO		I
				PESTAP		
DFFLUX	g cm^{-2}	Array	Diffusive/Dispersive	SLPEST	PEST	O
	day^{-1}		Flux of Pesticide Leaving	OUTPST		I
			Each Soil Compartment	OUTTSR		I
DIN	cm	Scalar	Current Plant Canopy	PLGROW	HYDR	O
			Interception Potential	HYDROL		I
				OUTHYD		I
DISP	cm^2	Array	Dispersion/Diffusion	READ	PEST	O
	day^{-1}		Coefficient	ECHO		I
				INITL		I
				SLPEST		I
DISS	mg l^{-1}	Array	Dissolved Portion of	OUTCNC		
			Pesticide in Each			
			Compartment			
DKFLUX	g cm^{-2}	Array	Decay Flux of Pesticide	SLPEST	PEST	O
			From Each Compartment	MASBAL		I
				OUTPST		I
				OUTTSR		I
DKRATE	day^{-1}	Array	Pesticide Decay Rate in	READ	PEST	O
			Each Soil Horizon	ECHO		I
				INITL		I
				SLPEST		I
DOM	-	Scalar	Number of Current Day of	PMAIN	MISC	O
			Month of Simulation	OUTHYD		I
				OUTPST		I
				OUTTSR		I
				OUTCNC		I
Dt	hr	Array	Average Hours of Daylight	READ	MET	O
			for a Day falling in Each	ECHO		I
			Month	EVPOTR		I
EF	kg ha^{-1}	Scalar	Daily Erosion Flux	OUTPST		
ELTERM	day^{-1}	Scalar	Erosion Loss Term for	EROSN	PEST	O
			Pesticide Balance	SLPEST		I
EMD	-	Scalar	Day of Month of Crop	READ		
			Emergence	ECHO		
EMM	-	Scalar	Month of Crop Emergence	READ		
				ECHO		
ENRICH	-	Scalar	Enrichment Ratio for	EROSN		
			Organic Matter			
ERFLAG	-	Scalar	Erosion Flag (0= Not	READ	HYDR	O
			Calculated 1= Calculated)	PMAIN		I
ERFLUX	g cm^{-2}	Scalar	Erosion Flux of Pesticide	SLPEST	PEST	O
			From Soil Surface	MASBAL		I
				OUTPST		I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
				OUTTSR		I
EXTRA	$cm^3\ cm^{-3}$	Scalar	Extra Water Occurring in a Compartment Over the Allowed Saturation Amount	HYDR2		
F	$g\ cm^{-2}\ day^{-1}$	Array	Vector of Source Terms for Each Compartment (Tri-diagonal Matrix)	SLPEST TRDIAG	PEST	O I
F0	$kg\ ha^{-1}$	Scalar	Current Foliar Pesticide Storage	OUTPST		
FAM	-	Scalar	Pesticide Application Flag (1= Soil, 2= Linear Foliar, 3= Exponential Foliar)	READ ECHO PESTAP	PEST	O I I
FC	cm	Array	Field Capacity Water Depth in Soil Compartment	INITL EVPOTR	HYDR	O
FCV	-	Array	Regression Coefficients for Prediction of Field Capacity Soil Water Content	THCALLC		
FDAY	-	Scalar	Loop Limit, First Day	PMAIN		
FEXTRC	cm^{-1}	Scalar	Foliar Extraction Coefficient for Foliar Washoff Model	READ ECHO PLPEST	PEST	O I I
FILTRA	$m^2\ kg^{-1}$	Scalar	Filtration Parameter for Exponential Foliar Application Model	READ ECHO PESTAP	PEST	O I I
FL	$kg\ ha^{-1}$	Scalar	Foliar Pesticide Decay Loss	OUTPST		
FOLP0	$g\ cm^{-2}$	Scalar	Foliar Pesticide Storage From Previous Time Step	PLPEST MASBAL OUTPST PMAIN	PEST	O I I I
FP	$kg\ ha^{-1}$	Scalar	Current Daily Foliar Pesticide Storage	OUTPST		
FPDLOS	$g\ cm^{-2}$	Scalar	Current Daily Foliar Pesticide Decay Loss	PLPEST MASBAL OUTPST OUTTSR	PEST	O I I I
FPWLOS	$g\ cm^{-2}$	Scalar	Current Daily Pesticide Washoff Loss	PLPEST		
FRAC	-	Scalar	Fraction of the Distance a Curve Number is Between Increments of Ten	READ		
FRAC	-	Scalar	Fraction of the Current Crop Growing Season Completed	PLGROW		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
FRAC	-	Array	Number of Compartments Available to Extraction of ET	EVPOTR		
FRACOM	-	Scalar	Fraction of Layer Attributed to the Current Horizon	INITL		
GAMMA	-	Array	Pesticide Uptake Efficiency by Plant	PLGROW SLPEST	PEST	O I
HAD	-	Scalar	Day of Month of Crop Harvest	READ ECHO		
HAM	-	Scalar	Month of Crop Harvest	READ ECHO		
HORIZN	-	Array	Soil Horizon Number	READ ECHO INITL OUTHYD OUTPST OUTCNC	MISC	O I I I I I
HSWZT	-	Scalar	Hydraulics Flag (0= Free Draining Soils, 1= Restricted Drainage)	READ ECHO INITL PMAIN		O I I I
HTITLE	-	Alpha-numeric	Comment Line to Enter Information about Hydrology Parameters	READ ECHO		
I	-	Scalar	Loop Counter	ALL SUP-ROUTINES		
IAPDY	-	Array	Julian Day of Pesticide Application	READ ECHO PMAIN	MISC	O I I
IAPYR	-	Array	Year of Pesticide Application	READ ECHO PMAIN	MISC	O I I
IARG	-	Array	Argument of Variable Identified by 'PLNAME'	READ ECHO OUTTSR	MISC	O I I
IARG1	-	Scalar	Argument of Variable Identified by 'PLNAME'	OUTTSR		
IB	-	Scalar	Backward Loop Index	INITL HYDR2		
IBM1	-	Scalar	Counter	INITL		
ICNAH	-	Array	Soil Surface Condition After Harvest	READ ECHO PLGROW	HYDR	O I I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Subroutine	Common	I,M,O
ICNCN	-	Array	Crop Number	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
IEDAY	-	Scalar	Ending Day of Simulation	READ	MISC	O
				PMAIN		I
				ECHO		I
IEDY		Scalar	Counter	INITL		
IEMER	-	Array	Julian Day of Crop Emergence	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
IEMON	-	Scalar	Ending Month of Simulation	READ	MISC	O
				ECHO		I
				PMAIN		I
IERROR	-	Scalar	Error Flag if Tri-Diagonal Matrix Cannot be Saved	SLPEST		
				TRDIAG		
IEYR	-	Scalar	Ending Year of Simulation	READ	MISC	O
				ECHO		I
				PMAIN		I
IFIRST	-	Scalar	Flag to Print Output Heading and Initialize Output Array	OUTTSR		
IHAR	-	Array	Julian Day of Crop Harvest	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
II	-	Scalar	Loop Counter	OUTPST		
IJ	-	Scalar	Loop Counter	PMAIN		
ILP	-	Scalar	Initial Level of Pesticide Flag (0= No Pesticide, 1= Initial Pesticide)	READ	MISC	O
				ECHO		I
INABS	cm	Scalar	Initial Abstraction of Water from Potential Surface Runoff	HYDROL	HYDR	O
				EROSN		I
INCROP	-	Array	Crop Growing in Current Cropping Period	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
				OUTHYD		I
				OUTPST		
INICRP	-	Scalar	Initial Crop Number if Simulation Starting Date is Before First Crop Emergence Date	READ	CROP	O
				ECHO		I
				INITL		I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
INTFC	-	Scalar	Whole Layer(s) Attributed to the Current Horizon	INITL		
IPEIND	-	Scalar	Pan Evaporation Indicator Flag (0= Data Read In, 1= Calculated)	READ	MET	O
				ECHO		I
ISCOND	-	Scalar	Surface Condition After Harvest Corresponding to 'INICRP'	READ	HYDR	O
				ECHO		I
				PLGROW		I
				HYDROL		I
				EROSN		I
ISDAY	-	Scalar	Starting Day of Simulation	READ	MISC	O
				ECHO		I
				INITL		I
				PMAIN		I
ISDY	-	Scalar	Counter	INITL		
ISMON	-	Scalar	Starting Month of Simulation	READ	MISC	O
				ECHO		I
				INITL		I
				PMAIN		I
ISTYR	-	Scalar	Starting Year of Simulation	READ	MISC	O
				ECHO		I
				INITL		I
				PMAIN		I
ITEM1	-	Alphanumeric	Hydrology Output Summary Indicator	READ	MISC	O
				ECHO		I
				OUTHYD		I
ITEM2	-	Alphanumeric	Pesticide Output Summary Indicator	READ	MISC	O
				ECHO		I
				OUTPST		I
ITEM3	-	Alphanumeric	Soil Pesticide Concentration Profile Output Indicator	READ	MISC	O
				ECHO		I
				PMAIN		I
ITEMP	degree C	Scalar	Mean Daily Temperature Rounded to Next Lowest Whole Number	EVPOTR	MISC	O
ITMP	-	Scalar	Number of Compartments Pesticide is Applied to When Incorporated	PESTAP		
IY	-		Annual Loop Counter	PMAIN		I
				PLGROW		I
				OUTHYD		I
				OUTPST		I
				OUTTSR		I
				OUTCNC		I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
IYREM	-	Array	Year of Crop Emergence	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
IYRHAR	-	Array	Year of Crop Harvest	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
IYRMAT	-	Array	Year of Crop Maturation	READ	CROP	O
				ECHO		I
				INITL		I
				PLGROW		I
J	-	Scalar	Loop Counter	PMAIN		
				READ		
				ECHO		
				INITL		
				PLGROW		
				OUTHYD		
				OUTPST		
JJ	-	Scalar	Loop Counter	READ		
JP1	-	Scalar	Counter (J+1)	READ		
JP1T10	-	Scalar	Counter (JP1*10)	READ		
JT10	-	Scalar	Counter (J*10)	READ		
JULDAY	-	Scalar	Julian Day	PMAIN	MISC	O
				PLGROW		I
				OUTHYD		I
				OUTPST		I
K	-	Scalar	Loop Counter	READ		
				ECHO		
KD	$cm^3\ g^{-1}$	Array	Adsorption/Partition Coefficient for Soil Compartment	READ	PEST	O
				ECHO		I
				INITL		I
				KDCALC		O
				PESTAP		I
				SLPEST		I
				MASBAL		I
				OUTPST		I
				OUTTSR		I
				OUTCNC		I
KDFLAG	-	Scalar	Partition Coefficient Flag (0= Kd Read In, 1= Kd Calculated)	READ		O
				ECHO		I
				PMAIN		I
KK	-	Scalar	Loop Counter	READ		
KOC	$cm^3\ g^{-1}$ -oc	Scalar	Organic Carbon Partition Coefficient	KDCALC		
L	-	Scalar	Lower Decomposed Matrix	TRDIAG		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
LDAY	-	Scalar	Loop Limit (Last Day)	PMAIN		
LEAP	-	Scalar	Additional Day Flag for Leap Year	READ ECHO INITL PMAIN OUTHYD OUTPST	MISC	O I I I I I
LFREQ1	-	Scalar	Frequency of Soil Compartment Reporting in Water Output Summary	READ OUTHYD	MISC	O I
LFREQ2	-	Scalar	Frequency of Soil Compartment Reporting in Pesticide Output Summary	READ OUTPST	MISC	O I
LFREQ3	-	Scalar	Frequency of Soil Compartment Reporting in Concentration Profile Output Summary	READ OUTCNC	MISC	O I
LOGKOC	-	Scalar	Natural Log of Koc	KDCALC		
MAD	-	Scalar	Day of Month of Crop Maturation	READ ECHO		
MAM	-	Scalar	Month of Crop Maturation	READ ECHO		
MAT	-	Array	Julian Day of Crop Maturation	READ ECHO INITL PLGROW	MISC	O I I I
MD	-	Scalar	Number of Day Read from Meteorologic File	PMAIN		
MDOUT	kg ha^{-1}	Array	Monthly Pesticide Decay from Each Compartment	OUTPST	ACCUM	M
MEOUTW	cm	Array	Monthly ET from Each Soil Compartment	OUTHYD	ACCUM	M
MINPP	kg ha^{-1}	Array	Monthly Advection/Dispersion Flux from Each Compartment	OUTPST	ACCUM	M
MINPP1	kg ha^{-1}	Scalar	Monthly Foliar Applied Pesticide	OUTPST	ACCUM	M
MINPP2	kg ha^{-1}	Scalar	Monthly Soil Applied Pesticide	OUTPST	ACCUM	M
MINPW	cm	Array	Monthly Infiltration into Each Soil Compartment	OUTHYD	ACCUM	M
MINPW1	cm	Scalar	Monthly Precipitation	OUTHYD	ACCUM	M
MINPW2	cm	Scalar	Monthly Snowfall	OUTHYD	ACCUM	M

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
MM	-	Scalar	Number of Month Read from Meteorologic File	PMAIN		
MINTH	-	Alpha-numeric	Flag for Monthly Output Summary (for Either Water or Pesticide)	PMAIN		
MNTHP1	-	Scalar	Current Month Plus 1 (Month + 1)	OUTHYD		
MODFC	-	Scalar	Fraction Multiplier	INITL		
MONTH	-	Scalar	Number of Current Month of Simulation	PMAIN EVPOTR OUTHYD OUTPST OUTTSR	MISC	O I I I I
MOUTP	kg ha^{-1}	Array	Monthly Pesticide Uptake from Each Compartment	OUTPST	ACCUM	M
MOUTP1	kg ha^{-1}	Scalar	Monthly Pesticide Washoff Flux	OUTPST	ACCUM	M
MOUTP2	kg ha^{-1}	Scalar	Monthly Pesticide Runoff Flux	OUTPST	ACCUM	M
MOUTP3	kg ha^{-1}	Scalar	Monthly Pesticide Erosion Flux	OUTPST	ACCUM	M
MOUTP4	kg ha^{-1}	Scalar	Monthly Foliar Pesticide Decay Loss	OUTPST	ACCUM	M
MOUTP5	kg ha^{-1}	Scalar	Monthly Pesticide Uptake Flux from Profile	OUTPST	ACCUM	M
MOUTP6	kg ha^{-1}	Scalar	Monthly Pesticide Decay Flux from Profile	OUTPST	ACCUM	M
MOUTW	cm	Array	Monthly Exfiltration from Each Compartment	OUTHYD	ACCUM	M
MOUTW1	cm	Scalar	Monthly Canopy Evaporation	OUTHYD	ACCUM	M
MOUTW2	cm	Scalar	Monthly Thrufall	OUTHYD	ACCUM	M
MOUTW3	cm	Scalar	Monthly Runoff	OUTHYD	ACCUM	M
MOUTW4	cm	Scalar	Monthly Snowmelt	OUTHYD	ACCUM	M
MOUTW5	cm	Scalar	Monthly Evapotranspiration	OUTHYD	ACCUM	M
MOUTW6	MTonne	Scalar	Total Monthly Sediment Loss	OUTHYD	ACCUM	
MSTART	-	Scalar	Flag for Positioning Meteorologic File	PMAIN		
MSTR	cm	Array	Previous Month Storage of Water in Each Soil Compartment	OUTHYD	ACCUM	M
MSTR1	cm	Scalar	Monthly Canopy Interception	OUTHYD	ACCUM	M

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
MSTR2	cm	Scalar	Monthly Accumulation of Snow	OUTHYD	ACCUM	M
MSTRP	kg ha^{-1}	Array	Storage of Pesticide from Previous Month in Each Soil Compartment	OUTPST	ACCUM	M
MSTRP1	kg ha^{-1}	Scalar	Storage of Foliar Pesticide from Previous Month	OUTPST	ACCUM	M
MY	-	Scalar	Number of Year Read from Meteorologic File	PMAIN		
N	-	Scalar	Number of Compartments in the Soil Profile	TRDIAG		
NAPPC	-	Scalar	Pesticide Application Counter	PMAIN PESTAP	PEST	O I
NAPS		Scalar	Number of Pesticide Applications in the Simulation	READ ECHO INITL PMAIN	PEST	O I I I
NBYR	-	Scalar	Beginning Year of Crop Growth for Current Crop (Loop Limit)	INITL PLGROW		
NCOM0	-	Scalar	Number of Compartments from Which ET is EXtracted Year Round	INITL PLGROW	HYDR	O I
NCOM1	-	Scalar	Current Number of Compartment that ET is Extracted From	PLGROW EVPOTR OUTHYD	HYDR	O I I
NCOM2	-	Scalar	Number of Compartments in Soil Profile	READ ECHO INITL PMAIN EVPOTR HYDR1 HYDR2 SLPEST MASBAL OUTHYD OUTPST OUTCNC	HYDR	O I I I I I I I I I I I
NCOM2M	-	Scalar	Number of Compartments in Soil Profile Minus 1 (NCOM2 = 1)	INITL SLPEST	HYDR	O I
NCOMRZ	-	Scalar	Number of Compartments in the Root Zone	INITL SLPEST OUTHYD OUTPST	CROP	O I I I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
NCP	-	Scalar	Number of Current Cropping Period	INITL PLGROW	CROP	O I
NCPDS	-	Scalar	Number of Cropping Periods in the Simulation	READ ECHO INITL PLGROW	CROP	O I I I
NCROP	-	Scalar	Number of Current Crop	INITL PLGROW HYDROL EROSN	CROP	O I I I
NDC	-	Scalar	Number of Different Crops in Simulation	READ ECHO INITL PLGROW	CROP	O I I I
NDCNT	-	Scalar	Number of Days Since Crop Emergence for Current Crop	INITL PLGROW	MISC	O I
NDYRS	-	Scalar	Number of Years Between Emergence and Maturation of a Crop	INITL PLGROW		
NEXDAY	-	Scalar	Extra Day Added for Leap Year	PLGROW		
NEYR	-	Scalar	Ending Year of Crop Growth for Current Crop	INITL PLGROW		
NHORIZ	-	Scalar	Total Number of Soil Horizons	READ ECHO INITL KDCALC	MISC	O I I I
NLINES	-	Scalar	Numbers of Lines for Listing Initial Pesticide in Profile (Loop Limit)	ECHO		
NM1	-	Scalar	Number of Compartments in Profile Minus 1 (NCOM2 - 1)	TRDIAG		
NOPRT	-	Scalar	Print Flag	OUTHYD OUTPST		
NPLOTS	-	Scalar	Number of Time Series to be Output (Maximum of 7)	READ ECHO PMAIN OUTTSR	MISC	O I I I
NRZCOM	-	Scalar	Current Number of Layers in Root Zone	PLGROW		
NSUM	-	Scalar	Cummulative Sum of Compartment Numbers	EVPOTR		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
NSUMM	-	Scalar	Termination Loop Index for Summary Output	OUTHYD		
				OUTPST		
OC	percent	Array	Organic Carbon Content of Each Soil Horizon	READ	PEST	O
				ECHO		I
				INITL		I
				THCALC		I
				KDCALC		I
ORGM	percent	Scalar	Organic Matter Content of a Soil Horizon	INITL		
OSNOW	cm	Scalar	Snow Accumulated at the End of the Previous Time Step	PMAIN	HYDR	O
				HYDROL		I
				MASBAL		I
OUTPUT	-	Array	Output Array for Time Series	OUTTSR		
PA	kg ha^{-1}	Scalar	Daily Foliar Pesticide Application	OUTPST		
PB	kg ha^{-1}	Scalar	Pesticide Balance	OUTPST		
PBAL	g cm^{-2}	Scalar	Current Pesticide Balance Error	MASBAL	PEST	O
				OUTPST		
PCMC	-	Scalar	Partition Coefficient Model Flag (1= Karickhoff, 2= Kenega, 3= Chiou)	READ	MISC	O
				KDCALC		I
PESTR	g cm^{-3}	Array	Total Pesticide in Each Soil Compartment	READ	PEST	O
				ECHO		I
				INITL		I
				PMAIN		I
				PESTAP		I
				MASBAL		I
				OUTPST		I
PET	cm	Scalar	Total Daily Potential Evapotranspiration	EVPOTR		
PETP	cm	Scalar	Running Total of Available Evapotranspiration	EVPOTR		
PEVP	cm	Scalar	Pan Evaporation	PMAIN	MET	O
				EVPOTR		I
PFAC	-	Scalar	Pan Factor for ET	READ	MET	O
				ECHO		I
				EVPOTR		I
PLDKRT	day^{-1}	Array	Foliar Pesticide Decay Rate	READ	PEST	O
				ECHO		I
				PLPEST		I
PLNAME	-	Alpha-numeric	Time Series Output Identifier (Options Listed in User's Guide)	READ	MISC	O
				OUTTSR		I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Subroutine	Common	I,M,O
PLNTAP	g cm^{-2}	Scalar	Pesticide Applied to Crop Canopy	PESTAP	PEST	O
				OUTPST		I
				OUTTSR		I
PNBRN	-	Array	Output Array for Time Series	OUTTSR		
PRECIP	cm	Scalar	Precipitation	PMAIN	MET	O
				HYDROL		I
				EROSN		I
				MASBAL		I
				OUTHYD		I
				OUTTSR		I
PTITLE	-	Alphanumeric	Comment Line to Input Information About Pesticide Parameters	READ	MISC	O
				ECHO		I
Q	m^{3}	Scalar	Runoff Volume	EROSN		
QQP	m^{6} sec^{-1}	Scalar	Runoff Energy Factor	EROSN		
RF	kg ha^{-1}	Scalar	Pesticide Runoff Flux	OUTPST		
RMULT	-	Scalar	Multiplication Factor for Time Series Output	OUTTSR		
RMULT1	-	Scalar	Multiplication Factor for Curve Number AMC I	READ		
RMULT3	-	Scalar	Multiplication Factor for Curve Number AMC III	READ		
RNSUM	-	Scaler	Converts NSUM to a Real Number	EVPOTR		
RNUM	ha cm^{-2}	Scalar	Numerator of Peak Runoff Rate	EROSN		
RODPTH	-	Scalar	Number of Soil Compartments that Affect Runoff	HYDROL		
ROFLUX	g cm^{-2} day^{-1}	Scalar	Runoff Flux of Pesticide From Land Surface	SLPEST	PEST	O
				MASBAL		I
				OUTHYD		I
				OUTTSR		I
RUNOF	cm	Scalar	Current Runoff Depth	HYDROL	HYDR	O
				PMAIN		I
				EROSN		I
				SLPEST		I
				MASBAL		I
				OUTHYD		I
				OUTTSR		I
RZD	cm	Scalar	Maximum Root Zone Depth for All Crops	INITL		
				OUTHYD		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
RZFLUX	g cm^{-2}	Scalar	Dispersive/Advective Flux of Pesticide Past the Bottom Root Zone Compartment	SLPEST OUTTSR	PEST	O I
RZI	-	Scalar	Active Root Zone Flag	INITL PLGROW	MISC	O I
SA	kg ha^{-1}	Scalar	Application of Pesticide to the Soil	OUTPST		
SAND	percent	Array	Percent Sand in Each Soil Horizon	READ ECHO INITL THCALC	HYDR	O I I I
SD	kg ha^{-1}	Scalar	Sum of the Decay Fluxes From All Compartments in Soil Profile	OUTPST		
SDKFLX	g cm^{-2} day^{-1}	Scalar	Sum of the Decay Fluxes From All Compartments in Soil Profile	SLPEST OUTPST	PEST	O I
SEDL	MTonne day^{-1}	Scalar	Erosion Sediment Loss	PMAIN EROSN OUTHYD	HYDR	O M O
SFAC	cm degree C^{-1}	Scalar	Snowmelt Factor	READ ECHO HYDROL	MET	O I I
SJDAY	-	Scalar	Starting Day of Simulation		INITL	
SLKGHA	kg ha^{-1} day^{-1}	Scalar	Erosion Sediment Loss	EROSN		
SMELT	cm	Scalar	Current Daily Snowmelt Depth	HYDROL EROSN OUTHYD	HYDR	O
SNOW	cm	Scalar	Snowpack Accumulation Depth	INITL PMAIN HYDROL MASBAL OUTHYD OUTTSR	HYDR	O I I I I I
SNOWFL	cm	Scalar	Current Snowfall Depth	HYDROL MASBAL OUTHYD OUTTSR	MET	O I I I
SOILAP	g cm^{-2}	Array	Pesticide Applied to the Soil	PESTAP PMAIN OUTPST OUTTSR	PEST	O I I I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
SOL	mole fraction mg l^{-1} umoles l^{-1}	Scalar	Pesticide Solubility - Karickhoff Model Kenaga Model Chiou Model	READ KDCALC		O I
SPESTR	g cm^{-3}	Array	Dissolved Pesticide in Each Soil Compartment	INITL PMAIN PESTAP SLPEST	PEST	O I I I
STEP1	-	Alpha-numeric	Time Step of Water Output Summary	READ ECHO OUTHYD	MISC	O I I
STEP2	-	Alpha-numeric	Time Step of Pesticide Output Summary	READ ECHO OUTPST	MISC	O I I
STEP3	-	Alpha-numeric	Time Step of Concentration Profile Output Summary	READ ECHO OUTCNC	MISC	O I I
STITLE	-	Alpha-numeric	Comment Line to Input Information About Soil Parameters	READ ECHO	MISC	O I
SU	kg ha^{-1}	Scalar	Sum of the Uptake Fluxes From All Soil Compartments	OUTPST		
SUMXP	kg ha^{-1}	Scalar	Sum of Soluble Pesticide in Profile	OUTPST		
SUPFLX	g cm^{-2} day^{-1}	Scalar	Sum of the Uptake Fluxes From All Soil Compartments	SLPEST OUTPST OUTTSR	PEST	O I I
SW	cm	Array	Current Water Depth in Each Soil Compartment	INITL HYDROL EVPOTR HYDR1 HYDR2 SLPEST OUTTSR	HYDR	O I I I I I I
T	-	Scaler	Fraction Compartment Check	INITL		
TAPP	g cm^{-2}	Array	Total Pesticide Applied Per Application	READ ECHO INITL PESTAP	PEST	O I I I
TEMP	degree C	Scalar	Ambient Air Temperature	PMAIN HYDROL EVPOTR	MET	O I I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
TERM	-	Scalar	Exponential Pesticide Washoff Term	PLPEST		
TERM1	-	Scalar	Exponential Pesticide Decay Term	PLPEST		
TERM2	-	Scalar	Product of Washoff and Decay Terms	PLPEST		
TFRAC	-	Scaler	Total Fraction of Compartments Available for Evapotranspiration Extraction	EVOPTR		
THEFC	$cm^3\ cm^{-3}$	Array	Field Capacity Water Content for Each Soil Horizon	READ	HYDR	O
				ECHO		I
				INITL		I
				THCALC		O
				HYDR1		I
				HYDR2		I
THETAS	$cm^3\ cm^{-3}$	Array	Soil Compartment Water Content at Saturation	INITL	HYDR	O
				HYDR2		I
THETH	$cm^3\ cm^{-3}$	Scalar	Soil Moisture Content Half Way Between Wilting Point and Field Capacity in the Top Soil Compartments	INITL	HYDR	O
				HYDROL		I
THETN	$cm^3\ cm^{-3}$	Array	Soil Water Content at the End of the Current Day for Each Soil Compartment	HYDR1	HYDR	O
				HYDR2		O
				PMAIN		I
				SLPEST		I
				MASBAL		I
				OUTHYD		I
				OUTPST		I
				OUTTSR		I
				OUTCNC		I
THETO	$cm^3\ cm^{-3}$	Array	Soil Water Content at the End of the Previous Day for Each Soil Compartment	READ	HYDR	O
				HYDR1		M
				HYDR2		M
				PESTAP		I
				SLPEST		I
				MASBAL		I
				OUTHYD		I
				OUTPST		I
THEWP	$cm^3\ cm^{-3}$	Array	Wilting Point Water Content for Each Soil Horizon	READ	HYDR	O
				ECHO		I
				INITL		I
				THCALC		O

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Subroutine	Common	I,M,O
THFLAG	-	Scalar	Soil Water Content Flag (0= Field Capacity and Wilting Point are Input, 1= Field Capacity and Wilting Point are Calculated)	READ ECHO PMAIN	MISC	O I I
THKNS	cm	Array	Soil Horizon Thickness	READ ECHO INITL HYDROL	MISC	O I I I
THRUFL	cm	Scalar	Precipitation that Falls Past the Crop Canopy to the Soil Surface	HYDROL OUTHYD OUTTSR	MET	O I I
TITLE	-	Alphanumeric	Title of the Simulation (User Supplied)	READ ECHO	MISC	O I
TNDGS	day	Array	Total Number of Days in Each Growing Season	INITL PLGROW	CROP	O I
TOL	-	Scaler	Fraction Compartment Check	INITL		
TOTAL	mg kg^{-1}	Array	Total Pesticide in Each Compartment	OUTCNC		
TR	hr	Scalar	Duration of Average Erosive Storm Event	READ ECHO EROSN	MET	O I I
TS	cm^3 cm^{-3}	Array	Previous Soil Compartment Water Content Minus Evapotranspiration	HYDR2		
TSW	cm	Scaler	Total Soil Water in Compartments Available for Evapotranspiration Extraction	EVOPTR		
TTHKNS	cm	Scalar	Total Thickness of Soil Profile (For Computational Check)	INITL		
TWLVL	cm cm^{-1}	Scalar	Fraction of Water to Soil Depth for Runoff Calculation	HYDROL		
TWP	cm	Scaler	Total Wilting Point Depth in Compartments Available for Evapotranspiration Extraction	EVOPTR		
U	-	Array	Upper Decomposed Matrix	TRDIAG		
UPF	kg ha^{-1}	Scalar	Daily Pesticide Uptake Flux in Profile	OUTPST		

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
UPFLUX	$g\ cm^{-2}$	Array	Uptake Flux of Pesticide From Each Soil Compartment	SLPEST OUTPST	PEST	O I
UPTKF	-	Scalar	Plant Pesticide Uptake Efficiency Factor	READ ECHO PLGROW	PEST	O I I
USLEC	-	Array	Universal Soil Loss Equation 'C' Factor	READ ECHO EROSN	HYDR	O I I
USLEK	-	Scalar	Universal Soil Loss Equation 'K' Factor	READ ECHO EROSN	HYDR	O I I
USLELS	-	Scalar	Universal Soil Loss Equation 'Ls' Factor	READ ECHO EROSN	HYDR	O I I
USLEP	-	Scalar	Universal Soil Loss Equation 'P' Factor	READ ECHO EROSN	HYDR	O I I
VAR1	$kg\ ha^{-1}$	Scalar	Daily Advection/Dispersion Flux of Pesticide Into a Compartment	OUTPST		
VAR2	$kg\ ha^{-1}$	Scalar	Daily Advection/Dispersion Flux of Pesticide Out of a Compartment	OUTPST		
VAR2D	cm	Scalar	Water Storage in a Single Compartment for the Previous Day	OUTHYD		
VAR2M	cm	Scalar	Water Storage in a Single Compartment for the Previous Month	OUTHYD		
VAR2RZ	$kg\ ha^{-1}$	Scalar	Daily Advection/Dispersion Flux of Pesticide Out of the Root Zone	OUTPST		
VAR2Y	cm	Scalar	Water Storage in a Singel Compartment for the Previous Year	OUTHYD		
VAR3	$kg\ ha^{-1}$	Scalar	Pesticide Storage in a Single Compartment for the Previous Day	OUTPST		
VEL	$cm\ day^{-1}$	Array	Water Velocity in Each Soil Compartment	HYDR1 HYDR2 SLPEST	HYDR	O O I
WBAL	cm	Scalar	Current Water Balance Error	MASBAL OUTHYD	HYDR	O I

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
WEIGHT	kg m^{-2}	Scalar	Current Plant Dry Foliage Weight	PLGROW	CROP	O
				PESTAP		I
WF	kg ha^{-1}	Scalar	Daily Pesticide Washoff Flux	OUTPST		
WFMAX	kg m^{-2}	Array	Maximum Plant Dry Foliage Weight at Full Canopy	READ	CROP	O
				ECHO		I
				INITL		I
WLVL	cm	Scalar	Total Soil Water in the Compartments that Affect Runoff	HYDROL		
WOFLUX	g cm^{-2} day^{-1}	Scalar	Washoff Flux of Pesticide From Plant Foliage	SLPEST	PEST	O
				OUTPST		I
WP	cm	Array	Wilting Point Water Depth in a Soil Compartment		HYDR	O
				EVPOTR		
WPV	-	Array	Regression Coefficients for Prediction of Wilting Point Soil Water Content	THCALC		
WTERM	g cm^{-2}	Scalar	Current Daily Pesticide Washoff Loss	PLPEST	PEST	O
				SLPEST		I
X	g cm^{-3}	Array	Dissolved Pesticide in Each Soil Compartment	TRDIAG	PEST	
				SLPEST	PEST	O
				MASBAL		I
				OUTPST		I
				OUTTSR		I
				OUTCNC		I
				PMAIN		I
XP	g cm^{-3}	Array	Total Pesticide in Each Soil Compartment	MASBAL		
Y	-	Array	Intermediate Matrix Solution Array	TRDIAG		
YDOUT	kg ha^{-1}	Array	Annual Pesticide Decay From Each Soil Compartment	OUTPST	ACCUM	M
YEAR	-	Alpha-numeric	Flag for Annual Water and Pesticide Summary Output	PMAIN		
YEOUTW	cm	Array	Annual Evapotranspiration From Each Soil Compartment	OUTHYD	ACCUM	M
YINPP	kg ha^{-1}	Array	Annual Advective/Dispersive Flux Into Each Soil Compartment	OUTPST	ACCUM	M
YINPP1	kg ha^{-1}	Scalar	Annual Pesticide Applied to Foliage	OUTPST	ACCUM	M

Table E-1. PRZM Program Variables, Units, Location, and Variable Designation (Continued)

Variable	Units	Type	Description	Sub-routine	Common	I,M,O
YINPP2	kg ha^{-1}	Scalar	Annual Pesticide Applied to Soil	OUTPST	ACCUM	M
YINPW	cm	Array	Annual Infiltration Into Each Soil Compartment	OUTHYD	ACCUM	M
YINPW1	cm	Scalar	Annual Precipitation	OUTHYD	ACCUM	M
YINPW2	cm	Scalar	Annual Snowfall	OUTHYD	ACCUM	M
YOUTP	kg ha^{-1}	Array	Annual Pesticide Uptake From Each Soil Compartment	OUTPST	ACCUM	M
YOUTP1	kg ha^{-1}	Scalar	Annual Pesticide Washoff Flux	OUTPST	ACCUM	M
YOUTP2	kg ha^{-1}	Scalar	Annual Pesticide Runoff Flux	OUTPST	ACCUM	M
YOUTP3	kg ha^{-1}	Scalar	Annual Pesticide Erosion Flux	OUTPST	ACCUM	M
YOUTP4	kg ha^{-1}	Scalar	Annual Foliar Pesticide Decay Flux	OUTPST OUTPST	ACCUM ACCUM	M M
YOUTP5	kg ha^{-1}	Scalar	Total Annual Pesticide Uptake Flux	OUTPST	ACCUm	M
YOUTP6	kg ha^{-1}	Scalar	Total Annual Pesticide Soil Decay Flux	OUTPST	ACCUM	M
YOUTW	cm	Array	Annual Exfiltration From Compartment	OUTHYD	ACCUM	M
YOUTW1	cm	Scalar	Annual Canopy Evaporation	OUTHYD	ACCUM	M
YOUTW2	cm	Scalar	Annual Trufall	OUTHYD	ACCUM	M
YOUTW3	cm	Scalar	Annual Runoff	OUTHYD	ACCUM	M
YOUTW4	cm	Scalar	Annual Snowmelt	OUTHYD	ACCUM	M
YOUTW5	cm	Scalar	Total Annual Evapotranspiration	OUTHYD	ACCUM	M
YOUTW6	MTonne	Scalar	Total Annual Sediment Loss	OUTHYD	ACCUM	M
YSTR	cm	Array	Previous Year Storage of Water in Each Soil Compartment	OUTHYD OUTHYD	ACCUM ACCUm	M M
YSTR1	cm	Scalar	Annual Canopy Interception	OUTHYD	ACCUM	M
YSTR2	cm	Scalar	Annual Snow Accumulation	OUTHYD	ACCUM	M
YSTRP	kg ha^{-1}	Array	Storage of Pesticide From Previous Year in Each Soil Compartment	OUTPST	ACCUM	M
YSTRP1	kg ha^{-1}	Scalar	Storage of Foliar Pesticide	OUTPST	ACCUM	M

ters will specify logical units for the meteorological, parameter input, water summary output, pesticide summary output, time series output, and pesticide concentration profile output files.

SEGMENTATION

Model overlays or segmentation may be required to fit PRZM on smaller computer systems. To determine whether segmentation is required, the program should be compiled and a link (or load) attempted. If the link fails due to lack of memory, segmentation is required. Segmentation allows the various PRZM subroutines to share the same memory locations.

There are two factors that will impact the method of segmentation; execution time and memory availability. Segmentation of any or all of the first five subroutines (READ, ECHO, THCALC, KDCALC, INITL) has very little impact on run-time as these subroutines are accessed only once, at the beginning of the simulation. To reduce the size of PRZM significantly, the largest of the subroutines should be segmented. These include READ, ECHO, OUTHYD, and OUTPST. Sizes of subroutines are generally output by the FORTRAN compiler.

It may be possible to avoid segmentation by reducing the size of the arrays found in the first PARAMETER statement. To help compute space savings, there are 34 arrays dimensioned by NCMPTS, 16 arrays dimensioned by NC, and 4 arrays dimensioned by NAPP in PRZM.

BLOCK DATA SUBPROGRAM

Accompanying the PRZM code is a Block Data subprogram used to initialize all parameters, state variables, and fluxes found in the COMMON blocks. This file is divided into two sections with the first devoted to input parameters and the second to all other variables in common. The input parameters are set equal to -999. or their default value to facilitate input checking. All other variables are set to zero. This is included for those machines that do not zero all memory space on their own.

OUTPUT FILES

As noted in the discussion of parameter statements, there are six input/output files that are used or can be generated by PRZM. Four of these are output files.

The hydrology (or water) output file contains an echo of the user inputs from the input file followed by daily, monthly and/or annual hydrology summaries. The output file must have a record length of 132 characters to accommodate this information. The echoing of input variables usually requires this information. The echoing of input variables usually requires no more than 120 records although longer simulation runs may require more. Each of the hydrology summaries (daily, monthly or annual) require at a minimum 55 records (assuming only two soil compartments are printed) and this number increases by one record for each additional soil compartment result printed.

Each pesticide summary output requires a record length of 132 characters with a minimum of 50 records of output. An additional record is added for each soil compartment result exceeding two printed out.

The pesticide concentration output requires a minimum of 12 records which must be of 50-character length. Again, each soil compartment result printed per summary requires an additional record.

FATAL ERROR MESSAGES

There are several locations in the PRZM code where the programs may terminate with a printed error message in the hydrology output file. Two of these locations are in the MAIN program, six are in SUBROUTINE READ and two are in SUBROUTINE INITL. All of these messages occur because of errors occurring in the input parameter data set. The error messages and the appropriate user responses are shown in Table E-2.

Table E-2. PRZM Fatal Error Messages and Appropriate User Actions

SUBROUTINE	ERROR MESSAGE	USER ACTION
MAIN	FORMAT ERROR IN THE INPUT SEQUENCE RECHECK INPUT FILE	Check for format errors in input sequence (e.g., real numbers in integer fields, etc.).
	END OF INPUT FILE FOUND TOO SOON RECHECK INPUT SEQUENCE	Check for missing lines in input sequence.
READ	NDC VALUE OF 'X' IS GREATER THAN NC VALUE OF 'Y'	Reduce value of NDC in input or increase value of NC in parameter statement.
	NCPDS VALUE OF 'X' IS GREATER THAN NC VALUE OF 'Y'	Reduce value of NCPDS in input or increase value of NC in parameter statement.
	NAPS VALUE OF 'X' IS GREATER THAN NAPP VALUE OF 'Y'	Reduce value of NAPS in input or increase value of NAPP in parameter statement.
	NCOM2+1 VALUE OF 'X' IS GREATER THAN NCMPTS VALUE OF 'Y'	Reduce value of NCOM2 in input or increase value of NCMPTS in parameter statement.
	NHORIZ VALUE OF 'X' IS GREATER THAN NCMPTS VALUE OF 'Y'	Reduce value of NHORIZ in input or increase value of NCMPTS in parameter statement.
	NPLOTS VALUE OF 'X' IS GREATER THAN 7	Reduce values of NPLOTS below 7 in input.
INITL	FATAL ERROR: SOIL PROFILE DESCRIPTION IS INCOMPLETE, INFORMATION READ IN FOR ONLY 'X' OF 'Y' CM	Reduce the value of CORED or increase the thickness of horizons so that they are greater than or equal to CORED.
	FATAL ERROR: SUM OF HORIZON THICKNESS EXCEEDS CORE DEPTH	Reduce the value of NHORIZ or increase CORED so that sum of horizon thickness equals core depth.

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